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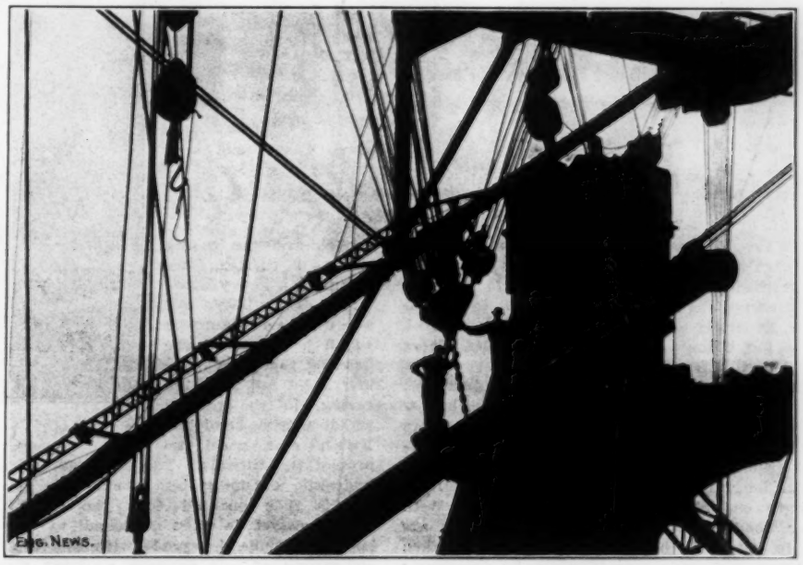
PROGRESS OF THE QUEBEC BRIDGE ACROSS THE ST. LAWRENCE RIVER.*

The great cantilever bridge over the St. Lawrence River, at Quebec, Canada, now being constructed, has made rapid progress during the working season of 1906. The contractors for the superstructure, the Phoenix Bridge Co., of Phoenixville, Pa., send us the view reproduced in the large cut below, to show the present condition of the structure. As will be seen, the cantilever arm of the south end is erected complete, five double panels (562 ft. 6 ins.) from the main pier. The extreme end of the arm as here shown is the point where the 675-ft. suspended span will begin. In contrast with this picture a view which appeared in our issue of June 28, 1906, p. 705, shows the status of the work in May. At that time the anchor-arm was not quite completed. The season's work comprises the construction of seven double panels, or 762½ ft. of bridge, including the very heavy members of the panels near the main pier.

The main part of the bridge is a pin-connected cantilever structure of pure type, 2,800 ft. long, consisting of a central span 1,800 ft. long (16 main panels at 112 ft. 6 ins.) and two anchor-arms each 500 ft. long (5 main panels at 100 ft.). The central span contains a suspended span 675 ft. long (6 panels at 112 ft. 6 ins.), carried on the ends of cantilever arms each 562 ft. 6 ins. long. The main structure connects with the top of the bank on either side by means of a 210-ft. pin-connected simple span, of deck type.



VIEW AT TOP OF MAIN POST OVER PIER; ASSEMBLED EYEBARS OF TOP CHORD PANEL BEING HOISTED INTO POSITION.

SOUTH ARM OF THE CANTILEVER BRIDGE OVER THE ST. LAWRENCE RIVER AT QUEBEC, NOV. 29, 1905.

The two trusses of the cantilever structure are 67 ft. apart c. to c., or about 62½ ft. clear. The depth of truss, between chord centers, is 315 ft. at the main piers, 97 ft. at the lowest points, and 130 ft. at the middle of the suspended span. The approach trusses, which are 35 ft. deep, are spaced 33 ft. apart. Mr. E. A. Hoare is Chief Engineer of the Quebec Bridge & Ry. Co., and Mr. Theodore Cooper is Consulting Engineer. Mr. John Sterling Deans is Chief Engineer of the Phoenix Bridge Co., which is building the superstructure.

*See Eng. News, Nov. 20, 1902, p. 419; Jan. 29, 1903, p. 99, substructure work; Sept. 14, 1905, p. 272, outline drawing; June 28, 1906, p. 705, progress photographs.

WASH DRILL BORINGS ON THE NEW YORK STATE BARGE CANAL.

By Emile Low,* M. Am. Soc. C. E.

The New York State Barge Canal, at the head of which is Mr. Frederick Skene, State Engineer and Surveyor, and Mr. William R. Hill, Special Deputy State Engineer, is making a very comprehensive examination of the sub-surface covered by this work, which in its magnitude

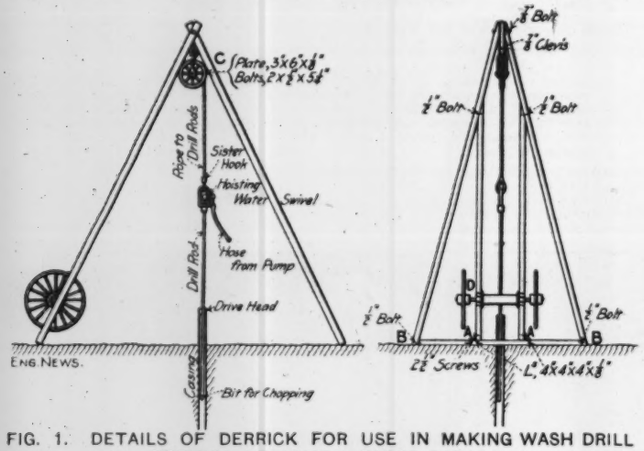


FIG. 1. DETAILS OF DERRICK FOR USE IN MAKING WASH DRILL BORINGS, NEW YORK BARGE CANAL.

riva's the Panama Canal. In this article it is the intention of the writer to give an account of the methods employed in making borings on the work named. For borings in earth, the apparatus generally called the wash drill is used, while for borings in rock the so-called Calyx drill is used.

The essential features of the wash drill are: the derrick or tripod, the casing, the hollow drill rods and hand force pump. Fig. 1 shows two elevations of the derrick, which is an ordinary tripod. A convenient size is one with legs 18 ft. long, made of 3 × 4-in. lumber. It is best to use pine, planed on all sides. With other wood, such as hemlock, the workmen are apt to get their hands full of splinters when handling the tripod, as it must be frequently shifted. The rope for raising and lowering the casing and drilling tools is manipulated either by hand or by means of a drum, rotated by two ordinary wagon wheels. The axle of these wheels is fastened to the two auxiliary legs of the tripod by suitable journal boxes, of either wood or iron. One wheel is usually keyed to the axle by means of a pin driven through the wheel hub, or by some other suitable device. The other wheel is allowed to run loose. When the derrick is not in use, and folded up, it can be hauled about in the same way or manner that a wagon would be.

The casing, generally known as flush joint, is composed of extra heavy pipe, preferably in 5-ft. lengths, provided at one end with male screw threads and at the other with female ones, so when the different lengths are screwed together they form a smooth exterior. The usual size used is nominally 2½ ins. inside diameter.

The drill rods are hollow, and are made of heavy seamless steel tubing, also usually in 5-ft. lengths, with female screw threads at each end. The rods are screwed together, section after section (as the hole deepens), by the insertion of male couplings, which are pieces of drill rods, 6 ins. long, threaded at each end for a length of 2 ins. The threads of both the casing and drill rods and appendages are cut in a lathe. The usual size of drill rod used with the 2½-in. casing is one having a 1⅞-in. outside diameter.

The other appendages of the drill rods are the hoisting water swivel at the top, and the X-chopping hydraulic bits at the bottom. The chopping bits are short pieces of drill rod, made of steel, fashioned at the lower end into four chisel-shaped edges, the four small perforations between them connecting with the larger single hole at the other end. This end is also threaded so it can be screwed into the lower end of the drill rod.

The hand pumps used are generally the Gould's "Challenge No. 8" double-acting force pumps, with single lever diameter cylinder, 4 ins.; stroke, 4½ ins.; 1½-in. suction.

The method of drilling a bore hole is as follows: Usually a shallow hole is dug with a shovel, and the casing placed therein. By means of a heavy hardwood drive block (or so-called hammer) which is raised by the hoisting rope, the hammer is let fall upon the casing, in the top of which a drive head has been screwed to protect the threads. The drill rod, with an X hydraulic chopping bit attached to the lower end is then inserted into the casing. The water swivel is then attached to the upper end, and connection made with the force pump. By means of this pump a constant stream of water is forced down through the hollow drill rods, which issues at the bottom through the perforated X bits.

While water is being pumped, the flush joint casing is worked down by a constant twisting of the same by pipe tongs, when working in suitable soil; otherwise it must be driven down with the wooden hammer. The drill rod, in suitable material, is worked down in much the same manner by twisting with pipe tongs. Where the material is harder it must be churned down. This is accomplished by raising it up and letting it fall, these operations being kept up until the required depth is rea... or until obstacles such as boulders ret... its progress. In case of boulders very ... all charges of dynamite can be used to ad... ge by intelligent foremen, but when this ... e care must be taken in raising the casi... gh enough to avoid damage from the resulti... x- plosion.

Where running streams are conveni... to the bore holes, water is taken from ... ; otherwise it is necessary to haul water in tanks, casks or barrels. Sometimes worn-out milk cans are utilized for this purpose.

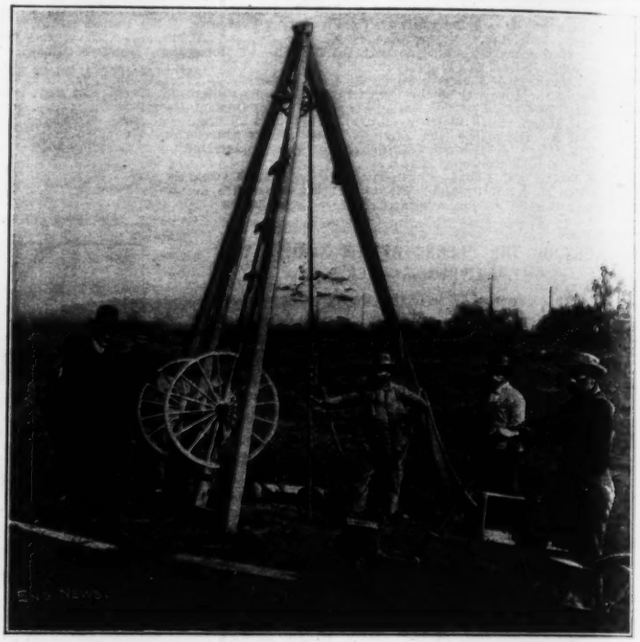


FIG. 2. WASH DRILL OUTFIT IN THE FIELD, NEW YORK BARGE CANAL.

The water, after issuing through the X bits, rises in the annular space between the drill rods and casings to the top, carrying with it all the loosened material. The overflow is caught in buckets, pans or other vessels, the material settling to the bottom.

Samples of the material penetrated are kept in 1 × 5-in. glass vials, six of which are assembled in small wooden boxes for preservation. These sample boxes are approximately 1⅞ ins. high, 4 ins. wide and 12 ins. long, outside measurements, and are divided into three long compartment by two thin partitions. On a scale of 1 in. to 1 ft. the six 5-in. vials represent 30 ft. of material, that being about the assumed average depth of a hole. In deeper

				INSPECTOR:	FOREMAN:
	HOLE NO. 134				Fred. H. Palmer
DATE	MATERIAL	DEPTH		ELEVATION	KIND OF DRILL: Wash
1905		FRM	TO		LOCATION OF HOLE: Lock No. 23
	ELEVATION OF GROUND			431.0	360 ft. South Sta. 6347+55
Dec. 1	Soil	0	2		
	Black Muck and				
	Rotten Wood	2	6		Palmer, Foreman
	Hard Pan	6	10		Osborn, Laborer
	do. do	10	16		Carpenter, do.
	Red Clay	16	20		Rooney, do.
	do. do	20	30		Ivins, Team
Dec. 4	do. do	30	40		
	do. do	40	50		Dec. 1-1905 Rock in Face
	Sandy Clay	50	53		" 2 " Rain, Snow, Sand
					Broke casing off 4 ft.
					in the ground and had
					to dig it out

FIG. 3. SAMPLE PAGE OF RECORD BOOK, WASH DRILL BORINGS ON NEW YORK BARGE CANAL.
(Original, 8½ x 7 ins.)

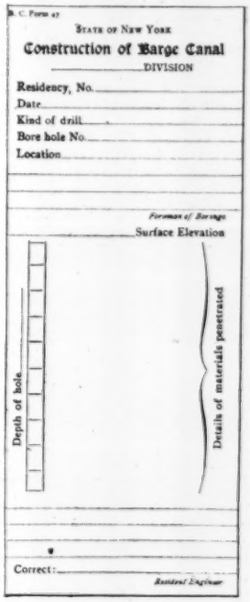
*Rome N. Y.

holes the scale can be changed to 2 ins. to 1 ft., and with shallower holes samples from two can be placed in one box. To properly record the character of the material penetrated and the depth below the surface of the ground a notebook is used.

Fig. 3 shows a sample page of this book. In addition there is placed in each sample box a slip (Fig. 4), on which is recorded by the foreman all the details of the hole, such as number, location, etc., as well as a diagram showing graphically the material penetrated. Later on a revised slip is prepared in India ink, on which all the above-mentioned information, together with the actual elevation and thickness of each strata are recorded. This is firmly glued on the inside of the lid of the sample box. In addition Dennison gummed labels are pasted on each sample vial, on which pertinent information as to the contents is recorded. All vials are properly corked. Labels are also attached to both the outside and inside of the sample box lids, on which number of hole, location, dates, etc., are recorded. In addition the one end of the box is suitably labeled with a rubber stamp for ready identification.

Weekly reports (Fig. 5) are rendered by the foreman, on which the details of all holes are shown. This report is an amplication of the individual report, shown by Fig. 4.

The force employed with one wash drill consists of one foreman and three laborers and a double team, wagon and sled, with driver, to haul water where not at hand or to move the plant to and from the work or between the bore holes. In instances where these are inaccessible to teams, the outfit must or can be easily carried by hand.


B. C. Form 47

STATE OF NEW YORK

Construction of Barge Canal

DIVISION

Residency, No.

Date

Kind of drill

Bore hole No.

Location

Foreman of Borings

Surface Elevation

Depth of hole

Details of materials penetrated

Correct:

Resident Engineer

Fig. 4. Record Slip of Wash Bore Hole for Placing in Sample Case.

(Original, 3 × 7 ins.)

It will be noticed from the description given that the casing, driving and drilling are alternate operations, the drill rod having to be withdrawn when the casing is to be driven deeper. By using a fiddle or double block (see Fig. 6) and a jar weight the operations of driving the casing and drilling and jetting with the drill rod can go on simultaneously, instead of intermittently. Instead of using the ordinary drive head, a hollow guide drive head is used, which is screwed into the top of the casing.

Two hoisting ropes are used, one to the drill rod, the other to the jar weight. By this arrangement the casing can be driven while the drill rod is being operated. The several operations of driving, jetting and chopping may be performed simultaneously or separately, as desired. This keeps the casing loose. A continuous wash sample is obtained as the casing descends.

The wash drill outfit described is for extended use when considerable work is to be done. These outfits are furnished by the American Rock Drill Co., of New York City, and also by the Sullivan Machinery Co., of Chicago.

Where boring work is done on a small scale, or only occasional holes are put down, a cheaper outfit can be used. For this purpose ordinary pipe can be used for casing, 2-in. being a good size. For the drill rods ¾-in. gas or water pipe can be used, with a water swivel made up of ordinary bends and nipples. Lighter X-bits can also be employed. Of course, an outfit of this kind is only temporary in character, and will only work in light soils or sandy material. In shallow holes, post-hole diggers can be used to

B. C. Form 61

CANAL IMPROVEMENT

DEPARTMENT OF STATE ENGINEER AND SURVEYOR

FOREMAN OF BORINGS WEEKLY REPORT

Residency, No. ..... Canal ..... For week ending ..... 19....

Bore hole No.							
Date							
Kind of drill							
Location							
Kind of Land							
SURFACE ELEVATION							
Use as many additional sheets as number of holes may require — Details of materials penetrated							
DEPTH OF HOLE							

WEEKLY EXPENSE DAY OF MONTH

NAME	TITLE	PAY	S.	M.	T.	W.	T.	F.	S.	TOTAL	AMOUNT

BORING	Kind of Drill	No. of holes	No. of feet	Cost	Cost per foot	CHARACTER OF MATERIAL DRILLED
In earth						
In Rock						

REMARKS

Foreman of Borings

FIG. 5. WEEK REPORT FORM, WASH DRILL BORINGS, NEW YORK BARGE CANAL.

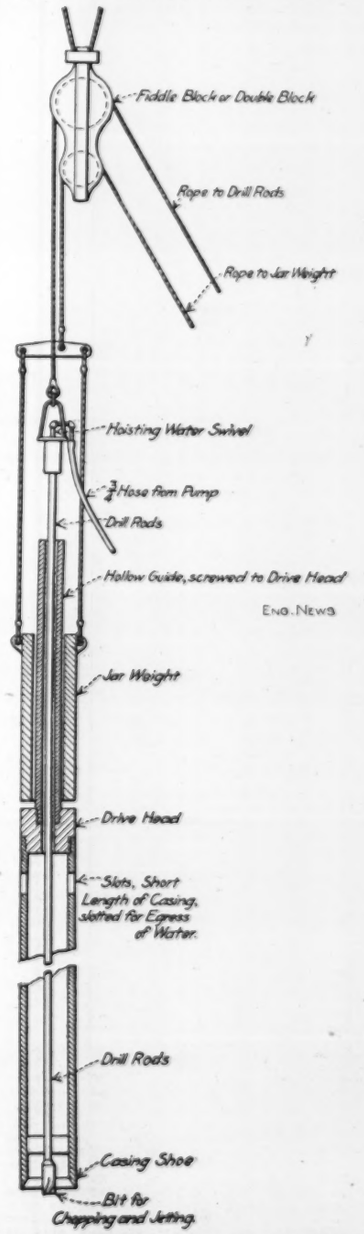


Fig. 6. Details of Wash Drill, Casing, Etc., New York Barge Canal.

advantage. Holes as deep as 16 ft. can be dug at less expense than with a wash drill, as a smaller force can be employed.

WASH DRILL OUTFIT.

Table I. includes a bill of material and detailed and summarized costs for a wash drill outfit, as described.

COST OF WASH DRILL BORINGS.

For the economical working of a wash drill boring party, the following force is needed:

1 foreman, at $3.50 per day	$3.50
3 laborers, at $2.00 per day	6.00
1 two-horse team and driver, at $3.50 per day	3.50
Daily cost	$13.00

This cost may be called the daily fixed expense. In addition there are variable expenses, such as cartage, express and freight on supplies, repairs to the outfit and to tools, as also the renewals of worn out parts and tools, and other minor expenses to be grouped under the general head of "Miscellaneous."

There are also certain fixed expenses for each hole drilled. These comprise the sample boring bottles and boxes, corks and labels. The bottles cost $2.25 per gross of 144, the boxes $16.75 per 100, the corks $0.14 per gross, and the labels $0.50 per dozen boxes.

Apportioning these various items, we have the cost per hole as follows: Bottles, 9.38 cts.; boxes, 16.75 cts.; corks, 0.60 cts.; labels, 0.80 cts.; total, 27.53 cts.

The cost of drilling is affected by many conditions, the most prominent of which is the nature of the material penetrated. In sand the progress is obviously faster than in hard clay and hardpan. The locality of the boring is also an important factor, whether they are located in dry ground or in a swamp, also whether the location is easy or difficult of access. Where borings are concentrated within a small area, as at a site for a lock or other structure, they can be made relatively cheaper than if the center line at more or less frequent intervals, the moving of the outfit being more expensive in the latter case.

Appended is a number of tables giving the actual expense of drilling wash drill bore holes on the work already described.

In Table II., the cost for October, 1904, is only for a partial month, no team is included as water could be obtained readily without hauling. The outfit was moved by hand from hole to hole. The cost for December, 1904, is not as favorable, being due to the flooding of the "Flats" by high water. The cold weather also

TABLE I.—BILL OF MATERIAL, WITH COSTS, FOR WASH DRILL OUTFIT USED ON NEW YORK BARGE CANAL.

Wash Drill Derrick.

3 pcs. pine, 3 × 4 ins. × 18 ft. = 54 ft. B.M. 2 pcs. pine, 3 × 4 ins. × 12 ft. = 24 ft. B.M. 1 pc. pine, 3 × 4 ins. × 9 ft. = 9 ft. B.M.		*$6.96
A 2 Iron agles, 4 × 4 × 4 × ⅛ ins.	= 2.24 lbs.	
B 2 Iron angles, 6 × 6 × 4 × ⅛ ins.	= 3.37 "	
C 1 Iron plate, 3 × 6 × ⅛ ins.	= 0.63 "	
D 1 Iron plate, 4 × 6 × ⅛ ins.	= 0.84 "	
2 Iron bolts & nuts, ½ × 5¾ ins.	= 1.04 "	
4 Iron bolts & nuts, ½ × 5¼ ins.	= 2.00 "	
12 Iron washers for ½-in. bolts	= 0.24 "	
20 Iron screws, 2½ ins. long	= 1.20 "	
1 Iron bolt, ⅞ × 11 ins.	= 1.85 "	
6 Iron washers for ⅞-in. bolt	= 0.69 "	
1 Iron clevis, ⅞ × 6 ins.	= 3.05 "	
1 Iron pair sister hooks	= 1.50 "	†1.87
1 16-in. iron single block		5.00
1 Hoisting rope, 1¼ ins. × 50 ft.		5.40
1 Pair wagon wheels, with axle		5.00
1 Wooden drum, 8 ins. dia., 2 ft. long		3.00
2 Journal boxes with 4 bolts = 5.84 lbs.		1.00
Total cost of derrick		$28.23

*87 ft. B. M. at $80 per M. B. M., made up.

†18.65 lbs., at 10 cts. per lb.

TABLE I.—(Continued.)

Flush Joint Casing.

10 pcs. flush joint casing, 2½ ins. dia.; 5 ft. long = 50 ft., 90 cts.	$45.00
1 Casing drive shoe	6.00
1 Casing drive head	6.00
1 Casing water spout	3.50
	$60.50
10 pcs. flush joint drill rods, 1¼ ins. dia.; 5 ft. long = 50 ft., 85 cts.	$42.50
10 Couplings for flush joint drill rods, $1.25	12.50
1 Hoisting water swivel	17.50
1 Hoisting swivel	8.00
3 X bits for chopping, $7.50	22.50
1 Spade bit	5.50
1 Shoe for taking dry samples	2.50
1 Worm auger	11.00
	$122.00
1 No. 8 Challenge hand force pump	$20.00
1 15-ft. 1½-in. suction hose, couplings & strainer	7.00
1 50-ft. ¾-in. 4-ply rubber hose, discharge	8.50
	$35.50

Tools.

1 Axe	$1.00
2 Bars, crow, 5 ft., 60 cts.	1.20
1 Chain	1.00
1 Chisel, cold	.65
2 Couplings, hose, 10 cts.	.20
1 Drive block, heavy hard wood	3.00
1 File, three-cornered	.10
1 File, flat	.25
1 Hammer, machinist	.85
1 Oiler	.30
1 Pick	1.00
1 Pail, galvanized iron	.25
3 Rings, tong, 15 cts.	.45
1 Saw	1.00
1 Screw driver	.25
1 Shovel	.60
1 Tape line	1.50
2 Tongs, pipe, 36-in., $4.20	8.40
1 Tool box	5.00
2 Unions, hose, 15 cts.	.30
2 Wrenches, Stillson, 8-in.	.75
1 Wrench, Stillson, 24-in.	2.00
1 Wrench, monkey, 6-in.	.45
1 Wrench, monkey, 15-in.	1.25
	$31.75

Recapitulation of Cost of Wash Drill Outfit.

Wash drill derrick	$28.23
Flush joint casing and accessories	60.50
Flush point drill rods and accessories	122.00
Hand force pump and accessories	35.50
Necessary tools	31.75
Grand total	$277.98

TABLE II.—COST OF WASH DRILL BORINGS ON NEW YORK BARGE CANAL, RESIDENCY NO. 5, ERIE CANAL.

Mohawk River Flats, Between Utica and Whitesboro.

	Oct., 1904. Total.	Oct., 1904. Per lin. ft., cts.	Nov., 1904. Total.	Nov., 1904. Per lin. ft., cts.	Dec., 1904. Total.	Dec., 1904. Per lin. ft., cts.
Labor	$198.00	21.81	$312.00	18.17	$246.50	26.64
Team	6.00	00.66	86.00	05.01	98.00	10.59
Repairs	.45	00.05	5.90	00.34	13.30	01.43
Sample boxes and bottles	14.79	01.63	27.03	01.57	16.83	01.72
Express and freight	1.72	00.19	.98	00.06	.....	.....
Traveling expenses	11.35	01.25	6.29	00.37	4.36	00.47
Sundries	1.33	00.15	18.78	01.09	.87	00.09
Total	$233.64	25.74	$456.98	26.61	$379.86	40.94
No. holes drilled	29		53		31	
No. feet drilled			1716.8		925.4	
Av. depth, ft.	31.3		32.4		29.8	

Character of material penetrated: Alluvial soil, yellow clay, fine sand, peat and silt.

TABLES III. to V.—COST OF WASH DRILL BORINGS, NEW YORK BARGE CANAL, RESIDENCY NO. 5, ERIE CANAL. WOOD CREEK VALLEY.

	TABLE III. (1) May, 1905. Total.	(1) May, 1905. Per lin. ft., cts.	(2) June, 1905. Total.	(2) June, 1905. Per lin. ft., cts.	(3) July, 1905. Total.	(3) July, 1905. Per lin. ft., cts.	(4) Aug., 1905. Total.	(4) Aug., 1905. Per lin. ft., cts.	TABLE IV. (5) Sept., 1905. Total.	(5) Sept., 1905. Per lin. ft., cts.	(6) Oct., 1905. Total.	(6) Oct., 1905. Per lin. ft., cts.	(7) Nov., 1905. Total.	(7) Nov., 1905. Per lin. ft., cts.	TABLE V. (8) Dec., 1905. Total.	(8) Dec., 1905. Per lin. ft., cts.	(9) Jan., 1906. Total.	(9) Jan., 1906. Per lin. ft. cts.
Bottles, sample	$2.63	0.0052	$2.72	0.0039	$0.28	0.0019	$3.19	0.0042	$3.47	0.0035	$2.81	0.0030	$1.97	0.0030	$2.35	0.0026	$3.56	0.0037
Boxes, sample	4.69	0.0004	4.86	0.0071	.50	0.0035	5.70	0.0074	6.20	0.0063	5.03	0.0053	3.52	0.0054	4.19	0.0045	6.37	0.0066
Cartage	....	....	.75	0.0011	15.00	0.1064	1.40	0.0018	.30	0.0003	.40	0.0004	.15	0.0002	....	....	.25	0.0003
Corks	.17	0.0003	.17	0.0002	.02	0.0001	.20	0.0003	.22	0.0002	.18	0.0002	.13	0.0002	.15	0.0002	.23	0.0002
Express	1.10	0.0022	.80	0.0012	....	....	1.10	0.0014	.85	0.0009	1.50	0.0016	1.45	0.0022	.40	0.0004	.75	0.0008
Freight	1.24	0.0025	.30	0.0004	....	....	1.36	0.0018	.50	0.0005	.93	0.0010	....	....	....	....	....	....
Fuel	....	....	....	....	14.22	0.1009	....	....	....	....	....	....	....	....	....	....	3.75	0.0038
Labels	.22	0.0004	.23	0.0003	.02	0.0001	.27	0.0004	.30	0.0003	.24	0.0003	.17	0.0003	.20	0.0002	.30	0.0003
Labor	224.00	0.4480	247.00	0.3595	247.00	1.7518	256.50	0.3353	247.00	0.2513	247.00	0.2630	247.00	0.3771	247.00	0.2685	256.50	0.2658
Miscellaneous	....	....	....	....	.31	0.0022	.60	0.0008	.10	0.0001	....	....	.10	0.0002	....	....	....	....
Repairs	8.10	0.0162	4.00	0.0058	15.16	0.1075	8.30	0.0109	.25	0.0003	13.30	0.0142	3.50	0.0053	6.75	0.0073	5.48	0.0057
Teams	77.00	0.1540	91.00	0.1325	87.50	0.6206	94.50	0.1235	87.50	0.0890	91.00	0.0969	84.00	0.1282	87.50	0.0951	91.00	0.0943
Tools	2.60	0.0052	.25	0.0004	.45	0.0032	1.25	0.0016	.47	0.0005	8.82	0.0094	2.75	0.0042	....	....	6.15	0.0064
Traveling expenses	2.78	0.0056	2.60	0.0038	.15	0.0011	.10	0.0001	....	....	1.50	0.0016	....	....	....	....	.10	0.0001
Totals	$324.53	0.6490	$354.68	0.5162	380.61	2.6993	374.47	0.4895	347.16	0.3532	372.71	0.3969	344.74	0.5263	348.54	0.3788	374.44	0.3880
Holes drilled	28		29		3		34		37		30		21		25		38	
Feet drilled	500		687		141		765		983		939		655		920		965	
Average depth, ft.	17.9		23.7		47.0		22.5		26.6		31.3		31.2		36.8		25.4	

Character of material: (1) Red, yellow and sandy clay, gray sand and hardpan. (2) Clay, sand and indurated clay, mixed with sand and stones, hardpan. (3) Clay, sand and hardpan. (4) Red clay, sandy clay, sand, muck and gravel. (5) Muck, sand, sandy clay, hard clay and hardpan. (6) Red and yellow clay, sand and hardpan. (7) Red and yellow clay and hardpan. (8) Red, yellow and sandy clay and hardpan. (9) Red, yellow and sandy clay and hardpan.

TABLES VI. AND VII.—COST OF WASH DRILL BORINGS, NEW YORK BARGE CANAL, RESIDENCY NO.5, ERIE CANAL.

TABLE VI.—WOOD CREEK AND MOHAWK RIVER VALLEYS.

	(1) Sept., 1906. Total.	(1) Sept., 1906. Per lin. ft., cts.	(2) October, 1906. Total.	(2) October, 1906. Per lin. ft., cts.	(3) November, 1906. Total.	(3) November, 1906. Per lin. ft., cts.
Bottles, sample	$5.91	0.0051	$6.66	0.0067	$4.69	0.0050
Boxes, sample	10.55	0.0092	11.89	0.0119	8.38	0.0090
Cartage	....	....	....	....	....	....
Corks	.38	0.0003	.43	0.0004	.30	0.0003
Express	....	....	.80	0.0008	1.62	0.0017
Freight	....	....	....	....	....	....
Fuel	....	....	....	....	....	....
Labels	.50	0.0004	.57	0.0006	.40	0.0005
Labor	187.50	0.1626	226.50	0.2265	247.00	0.2656
Miscellaneous	.26	0.0002	.34	0.0003	.30	0.0003
Repairs	1.66	0.0014	4.58	0.0046	5.83	0.0063
Teams	84.00	0.0729	94.50	0.0945	84.00	0.0903
Tools	....	....	.43	0.0004	....	....
Traveling expenses	....	....	....	....	....	....
Total	$290.76	0.2521	$346.70	0.3467	$352.52	0.3790
Holes drilled	63		71		50	
Feet drilled	1,153		1,000		930	
Average depth, ft.	18.3		14.1		18.6	

Character of material: (1) Sand, blue clay, clay and gravel mixed, muck, clay, sand and gravel overlying slate rock. (2) Clay, sand and gravel overlying slate rock; also hardpan. (3) Clay, sand and gravel overlying slate rock; also hardpan.

TABLE VII.—MOHAWK RIVER VALLEY.

	(1) Sept., 1906. Total.	(1) Sept., 1906. Per lin. ft., cts.	(2) October, 1906. Total.	(2) October, 1906. Per lin. ft., cts.	(3) November, 1906. Total.	(3) November, 1906. Per lin. ft., cts.
Bottles, sample	$4.60	0.0023	$4.50	0.0032	$3.47	0.0022
Boxes, sample	8.21	0.0041	8.04	0.0058	6.20	0.0040
Cartage	....	....	....	....	....	....
Corks	.29	0.0001	.29	0.0002	.22	0.0001
Express	.25	0.0001	....	....	....	....
Freight	....	....	....	....	.25	0.0002
Fuel	....	....	....	....	2.00	0.0013
Labels	.39	0.0002	.38	0.0003	.30	0.0002
Labor	237.50	0.1196	256.50	0.1832	247.00	0.1586
Miscellaneous	2.50	0.0013	1.30	0.0009	1.07	0.0007
Repairs	5.50	0.0028	5.85	0.0041	9.50	0.0061
Teams	87.50	0.0441	94.50	0.0675	91.00	0.0584
Tools	.25	0.0001	.20	0.0002	1.00	0.0006
Traveling expenses	1.50	0.0008	1.50	0.0011	1.70	0.0011
Total	$348.49	0.1755	$373.06	0.2665	$363.71	0.2335
Holes drilled	49		48		37	
Feet drilled	1,985		1,400		1,557	
Average depth, ft.	40.5		29.2		42.1	

Character of material: (1) Soft clay, sandy clay, sand and gravel. (2) Soft clay, peat, sand and gravel. (3) Clay, sand, silt and gravel.

influenced the progress of the work to a great extent. The material was very favorable for drilling, being mostly fine sand.

The borings covered by Table III. were made by a different foreman than the one who drilled the holes shown in Table II. The work done was at two lock sites, where the underlying material was hard clay and hardpan. It will be noted that the cost for July, 1905, was quite high. The three holes mentioned were drilled with a Cabot drill, the same being used as a wash drill, and was therefore a more expensive machine to use than the ordinary wash drill outfit. The borings reported in Tables IV. and V. were at sites for locks, culverts and bridges, and along the center line, the sites being quite far apart and considerable moving being necessary. The same foreman made the borings shown by Tables III., IV., and V.

The borings covered by Table VI. were made by still another foreman. They are borings at lock and spillway sites, and show lower costs than those previously mentioned. The reason is that a lighter outfit was used, and one man less was employed on the boring force for part of the time. Many of the holes were quite shallow, making quicker progress possible. The material was also easier to penetrate.

Table VII. includes borings made by another foreman. The holes were at a lock site and along the center line. The material was very soft clay, and also sand, which was easily penetrated, hence making good progress possible.

In the cost records given, the cost of the plant used is not included, neither is the cost of extraordinary repairs. An outfit should last for several years, the only part requiring frequent renewal being the flush joint casing, the threads of which require more or less re-cutting, depending on the material penetrated. Assuming that an outfit is good for driving 15,000 lin. ft. of holes, the cost for plant would add 2 cts. per lin. ft. to the figures given above. This is a conservative estimate and not far from the truth.

COST OF WASH DRILL BORINGS ON THE DEEP WATERWAYS SURVEYS, 1897 TO 1900.*

On preceding pages we print an article by Mr. Emile Low, M. Am. Soc. C. E., giving the cost of the wash drill borings made on the New York State Barge Canal, Residency No. 5 Erie Canal. In this connection it is interesting to refer to the wash drill borings made under the direction of the Board of Engineers on Deep Waterways between the Great Lakes and the Atlantic Tide Waters, during the years 1897 and 1900.

Very extensive borings by both wash and diamond drills were made along the various routes, to determine the character of the material underlying the ground surface, the data so obtained being used in the classification of the excavation. A compilation of the data, as scattered through the exhaustive report of the Board, gives the unit cost of these wash borings on some of the routes surveyed, as follows:

	Cost per lin. ft.
Tonawanda-Olcott route, La Salle-Lewiston route	$0.684
Oswego-Mohawk route, Western Division	0.706
Oswego-Mohawk route, Eastern Division	0.541
Champlain route, Lake Champlain	0.112
Champlain route, Hudson River Division, Whitehall to Troy Dam	0.130
Hudson River	0.251
Champlain route, St. Lawrence Division	0.852

We also give below summaries of the methods employed on the different routes, as well as the materials encountered and other valuable pertinent data.

HUDSON RIVER, BETWEEN TROY AND HUDSON CITY.—The rock found in the Hudson River is what is known as Hudson River shale. The other material met with in the river consists of boulders, gravel, coarse and fine sand, clay and silt. Nearly all the borings relating to the investigation of the Hudson River below the State dam at Troy, N. Y., were taken from a catamaran and scows constructed for that purpose, and the method employed was as follows:

The crew for each boring outfit generally consisted of one foreman and three laborers. Two and one-half in. pipe, commercially known as "2½-in. R. H. flush joint casing," manufactured in lengths from 1 to 10 ft., was lowered to the bed of the river, and hollow rods, commonly known as "B drill rods," with an X-bit attached, were inserted into the casing, the upper end of the rod being connected with a hand force pump, which was kept on the scow.

It was the duty of one man to work the pump and force water through the drill rods, while the other worked the drill by hand. The drill loosened the material, which was then forced upward through the casing. As the drill advanced into the bed of the river it was followed by the casing. Quite frequently very formidable obstructions were encountered by the drills, such as large cobblestones and bowlders, and more forcible measures had to be resorted to in order to pass them. When that was the case the drill rods were removed from the casing and one-half to two sticks of 40% Atlas powder were lowered into the hole, having previously been connected with a battery on the scow. The casing was then hoisted from 4 to 6 ft. above the bottom of the hole and the powder exploded. This plan would generally remove the obstruction, after which the work would be continued until another boulder was met.

In some of the bore holes between Troy and Albany it would require from 10 to 30 shots to advance below the depth of excavation necessary for a 30-ft. channel, or to the surface of bed rock.

Samples were taken when the flow through the casing indicated that a different stratum was encountered, or when it was considered necessary.

In all, 1,385 borings were made, with a total of 28,965 ft. of driving, at a cost of 25.11 cts. per lin. ft., including cost of plant.

The following is a detailed statement of the cost of these borings: Salaries and subsistence, $5,653; traveling expenses, $300; plant, $1,106; explosives, $106; freight and express, $69; office expenses, $40, total, $7,274.

LAKE ERIE TO LAKE ONTARIO, TONAWANDA-OLCOTT AND LA SALLE-LEWISTON ROUTES.—Borings were made along the general line of the survey and covered the entire width of any probable location of the channel. The cross sections on which they were taken were generally spaced about 1,500 ft. apart. They were carried to a depth below the grade of the 30-ft. channel, or to bed rock, no attempt being made to penetrate the rock farther than to satisfactorily determine that it was bed rock struck and not detached bowlders. Samples were taken of the various kinds of material penetrated, preserved in bottles and properly labeled for identification.

The force for making borings consisted of one superintendent of borings and three boring crews, each composed of one foreman, three laborers and one teamster, with team to haul water and move the machines from hole to hole.

In all, 404 borings were made, with a total of 9,624 ft. of driving, at a cost of 68.4 cts. per lin. ft., including plant, repairs, labor and all other expenses connected therewith, except surveys for location of holes. The plant for borings was considered sunk when the work was completed, and its entire cost proportioned against the routes on which it was used.

The material penetrated on the La Salle-Lewiston route was: Earth, sand, gravel, clay and hardpan. On the Tonawanda-Olcott route it was sand and gravel, and sand, yellow clay mixed with sand, soft red clay, hard clay and hardpan.

The following is a detailed statement of the cost of these borings: Tonawanda-Olcott route—Salaries and subsistence, $4,240; traveling expenses, $56; plant (tools, repairs, etc.), $522; explosives, $140; office expenses, $23; total, $4,981.

La Salle-Lewiston route—Salaries and subsistence, $1,312; traveling expenses, $67; plant (tools, repairs, etc.), $127; explosives ,$84; freight and express, $1; office expenses, $10; total, $1,601.

OSWEGO-MOHAWK ROUTE, WESTERN DIVISION.—Borings were made in Peter Scott's Swamp, Oneida Lake, Oswego River, Oswego Harbor and along the line of survey between Oswego and Rome. The borings in Oneida Lake were done in the winter time, when its surface was frozen, through the resulting ice. The material in the bed of this lake proved to be mostly thin mud, with occasional bars of sand and gravel, and a little rock near the outlet. The boring was therefore very easy and made rapid progress.

The borings in Oswego River were made by mounting a boring machine on a small flatboat, which had an open well near the center through which the drill and casing could be worked. The borings in Oswego Harbor were made in this same manner.

In all, 750 borings were made, with a total of 33,711 ft. of driving (depth of water not included), at a cost of 70.6 cts. per lin ft., including cost of plant.

The following is a detailed statement of the cost of these borings: Salaries and subsistence, $19,646; traveling expenses, $220; plant (tools, repairs, etc.), $3,035; explosives, $508; freight and express, $204; office expenses, $199; total, $23,812.

OSWEGO-MOHAWK ROUTE, EASTERN DIVISION.—Three different styles of boring machines were used on this division during the progress of the work, and a fourth one, different from each of the others, for a short time during its last stages.

The first machine used was a Pierce Well Boring Machine. The second style was a simple tripod, with pulley at the top and a rope passing over the same, to one end of which either a large wooden maul was attached for driving the casing or else the drill rods for washing out the same. The third type was in construction similar to a small pile driver, with a base of about 4 ft. between foot of leads and brace and extending out about 2½ ft. in front of the leads. It was about 15 ft. in height with leads protected by thin iron strips, in which an iron hammer, with a hollow in the bottom for a wooden cushion, was moved up and down by a rope attached to and passing over an 8-in. pulley at the top. Another pulley was set in a bracket just in front of the leads at the top, and was used to pass a rope over, to which the drill rods were attached.

Statement showing depth penetrated, kinds of material excavated, etc., for the various routes.

	Test soundings by hand with steel rod in Mohawk Valley.	Test borings with machine on land and river in Mohawk Valley.	Test borings with machine on cross-country lines and additional borings in Mohawk Valley.	Total
Number of land borings	....	894	271	1,165
Number of river borings	....	397	....	397
Number of soundings	290	....	....	290
	ft.	ft.	ft.	ft.
Earth	....	7,139	472	7,611
Sand	53	17,097	3,556	20,706
Clay	36	3,762	6,082	9,880
Blue clay	....	....	177	177
Gravel	118	2,678	19	2,815
Shale	....	44	117	161
Hardpan	....	40	60	100
Quicksand	....	664	865	1,529
Sand and gravel	290	1,637	801	2,728
Sand and clay	....	726	2,450	3,176
Clay and gravel	....	....	760	760
Sand and shale	....	35	227	262
Clay and shale	....	900	2	902
Gravel and stone	....	....	105	105
Gravel and boulder	....	....	177	177
Hardpan and boulder	....	....	87	87
Hardpan and stone	....	....	36	36
Sand and cobble	....	....	63	63
Gravel and shale	....	292	....	292
Sand, gravel and stone	....	22	55	77
Sand, loam and mud	173	727	....	900
Sand, clay and gravel	....	1,843	....	1,843
Gravel and cobble	....	33	58	91
Mud	417	....	....	417
Rock	....	413	213	626
Total penetration, ft.	1,087	38,052	16,382	55,521

Average penetration of 290 soundings in Mohawk River (exclusive of depth of water)	3.7 ft.
Average penetration of 1,291 borings in Mohawk Valley	29.5 ft.
Average penetration of 271 borings on cross-country lines and for dam and lock sites	60.4 ft.
Average penetration of 1,562 borings, total on all lines	34.8 ft.
Average cost per ft. of 55,521 lin. ft., total penetration of all borings and soundings	$0.54

*Proposed Ship Canal between the Great Lakes and the Atlantic Tide Waters.

The iron hammer weighed on one machine about 160 lbs. and on the other about 180 lbs., and was used for driving the casing, the machine being slipped back about 18 ins. by a bar when drilling was in progress. The machine was guyed by two ropes attached to the top and fastened to iron pins driven in the ground.

This machine, with all the tools, could be loaded on a two-horse wagon in about fifteen minutes and could be set up ready for work in about the same time. It rendered effective service, especially when the casing was hard to drive and the holes deep. The fourth type was the Sullivan machine, of which two were used for about one month during the last part of the work, one on land and one on river borings.

The varying conditions met with and different kinds of material encountered render comparisons difficult between the results obtained from different machines and methods.

The accompanying tabulated statement, showing depth penetrated in different kinds of material, with total penetration and cost of same per foot, may be of interest. The borings varied in depth from a few feet to a maximum of from 100 to 190 ft. The price per foot includes all items of cost, including plant.

The following is a detailed statement of the cost of these borings: Salaries and subsistence, $26,471; traveling expenses, $688; plant (tools, repairs, etc.), $2,287; explosives, $182; freight and express, $132; office expenses, $298; total, $30,058.

CHAMPLAIN ROUTE, HUDSON RIVER DIVISION.—This division begins at deep water in Lake Champlain opposite Port Henry and follows southerly up the lake to Whitehall, where it cuts across country southwesterly to the Hudson River near Fort Edward, following generally the valleys of Wood Creek and Bond Creek. From Fort Edward to the State dam at Troy, which is the southern end of this division, the channel follows generally the bed of the Hudson River. Between the Troy dam and Waterford the borings were in the river. From Troy to Fort Edward one party, consisting of a foreman, three laborers and a teamster with team, made the borings on land, and one party, consisting of a foreman and three laborers, made the borings in the river. After reaching Fort Edward the river party was changed to a land party, thus giving two land parties for the work between Fort Edward and Whitehall. For the land work the same plant was used as on the Niagara routes, and that for the river work only varied in having a catamaran from which to put down the holes. It was better adapted to the work than a scow, in that it could be taken apart and carried around the several dams in the river. From Whitehall to Port Henry, a distance of 36 miles, the channel is located in Lake Champlain. To make and locate soundings and borings in open water would require a large force and be very expensive, so it was decided to wait until the lake froze over and do this work on the ice.

On account of the cold weather the machines used for making the borings could not be operated without protection for the pumps and water swivels. This was afforded by building a small shanty on runners and moving it from hole to hole with a team. It was provided with a stove and trap doors in the floor and roof, through which the drill rods could be passed. The men worked inside. Each of the three boring parties was provided with one of these shanties, and they were admirably adapted to the work for which they were used. There was no difficulty in working when the temperature was —30° F., while in the open air the pumps would freeze up when it was colder than + 20° F.

For the purpose of considering the cost of the work the line is divided into two parts, one taking in Lake Champlain and the other that part of the line between Whitehall and Troy. All plant was considered as sunk when the work was completed and its cost proportioned to the various routes on which it was used. Lake Champlain: Cost of borings, $2,268; linear feet of borings, 20,169; cost per foot, 0.1124 cts. Whitehall to Troy dam: Cost of borings, $4,905; linear feet of borings, 37,822; cost per foot, 0.1297 cts.

The material in the lake is silt and sand. Between Port Henry and Putnam the earth is mostly sand, mixed with more or less silt and mud. Near Whitehall it is soft silt and mud, mixed with a small amount of sand.

The following is a detailed statement of the cost of these borings: Salaries and subsistence, $6,288; traveling expenses, $156; plant, $561; explosives, $41; freight and express, $50; office expenses, $74; total, $7,171.

CHAMPLAIN ROUTE, ST. LAWRENCE DIVISION.—This comprises the St. Lawrence River from Ogdensburg to Lake St. Francis. Work was done with a Sullivan boring machine for work on either land or water. The following work was done: 148 borings on land, aggregating 7,052 lin. ft.; 151 borings on water, 2,123 lin. ft.; total, 9,175 lin. ft.

The usual formation is bowlder clay, some of which is cemented and classified as "hardpan." There is also soft blue clay, and a small proportion of tough yellow clay. The gravel found is angular, and is from local rock.

The following is a detailed statement of the cost of these borings: Salaries and subsistence, $6,103; traveling expenses, $438; plant, $831; explosives, $319; freight and express, $73; office expenses, $55; total, $7,819. Cost per lin. ft., 0.852 cts.

WASH BORINGS FOR THE RAPID TRANSIT COMMISSION, NEW YORK CITY.

On Sept. 20, 1905, the Rapid Transit Commission of New York City received proposals for wash borings to be made on the lines of proposed railway routes. The following is the bid of the Healey Sewer Machine & Construction Co., the successful contractor:

		Feet.	Price.	Amount.
Sec. 1.	Borough of Manhattan, 14th St., south to Battery.	14,500	$0.50	$7,250
Sec. 2.	Borough of Manhattan, 14th St., north to Harlem River	11,000	.50	5,500
Sec. 3.	Borough of The Bronx, north and east of Harlem River	5,400	.45	2,430
Sec. 4.	Boroughs of Brooklyn and Queens, all routes	16,000	.45	7,200
Sec. 5.	Under the East River, Harlem River, Cromwell and Newtown Creeks	11,500	1.15	13,225
		58,400		$35,605

On June 4, 1906, this same Commission received bids for additional wash borings as below, the Healey Sewer Machine & Construction Co. being again the successful contractor:

		Feet.	Price.	Amount.
Sec. 2.	Borough of Brooklyn, Bensonhurst, Bath Beach and Coney Island route	1,300	$0.60	$780
Sec. 3.	Borough of Manhattan	1,300	.45	585
		2,600		$1,365

In this connection it may be stated that proposals were also received for diamond drill borings, which are not included in the above.

The following information regarding these borings is given by Mr. George S. Rice, Chief Engineer of the Rapid Transit Commission:

In connection with the first contract (1905), in order to comply with the requirements of the Department of Water Supply, Gas & Electricity, it was necessary to engage a certain number of inspectors connected with that department to superintend this work in behalf of the Department of Water Supply. The cost of this inspection was borne by the Rapid Transit Board and amounted to $2,449. For the use of water hydrants $40 was also paid to the Department of Water Supply. To contain the samples of boring material, 5,000 tin cans were purchased at the time of the letting of the first contract in 1904, the cost being paid for the same. A sufficient number of these cans remained to provide for the sampling of the borings under the second contract.

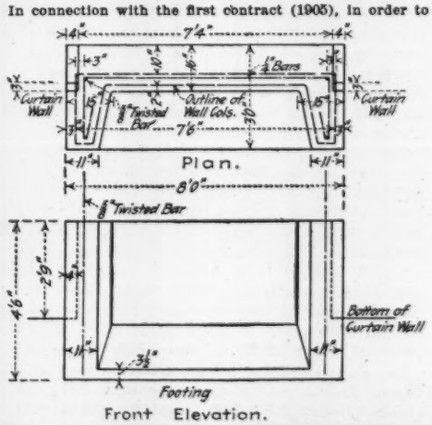


FIG. 1. FOOTING UNDER COLUMNS IN FACTORY FOR RANSOME CONCRETE MACHINERY CO., PLAINFIELD, N. J.

AN ECONOMICAL REINFORCED CONCRETE SH... CONSTRUCTION.

In an editorial in this journal of June 14, ... we said:

Ways and means for reducing [the cost of centering] forms in reinforced concrete] are evidently worthy ... most careful thought, yet while we have had volum...

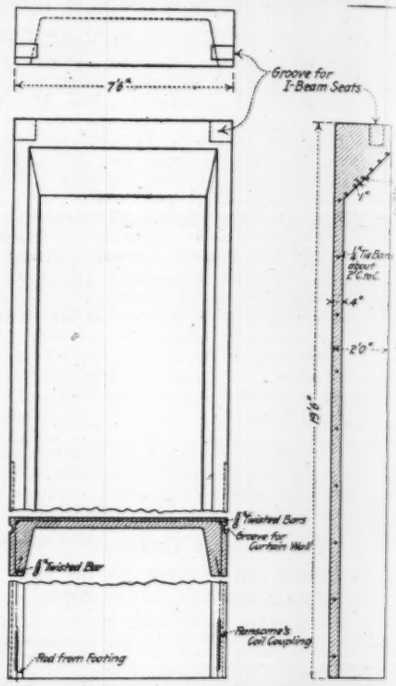


Fig. 2. Detail of Columns in Reinforced Concrete Wall Construction.

discussion on the theory and calculation of beams, columns and arches in reinforced concrete, there is an almost total lack of printed information on economical form work. . . .

In this connection the accompanying drawings and description are of interest as an illustration of the care that is now being taken to design concrete structures with a view toward an economical system of forms. The work herein described is the construction of the walls of the reinforced concrete shops now being erected at Plainfield, N. J., by the Ransome Concrete Machinery Co. These shops are to occupy a tract 200 x 1,200 ft. in area, and will, when completed, comprise four one-story buildings, ranging from 500 to 600 ft. in length and from 50 to 60 ft. in width, together with several smaller buildings.

The system of construction consists of a series of channel-shaped columns (Fig. 2), resting on similarly shaped footings (Fig. 1) and connected by thin curtain walls which fit into grooves in the columns. These curtain walls, which are slightly reinforced near the bottom, act merely as a means of enclosing the building, all the weight of the structural steel roofs being carried directly to the columns and to I-beams running longitudinally on the columns. The width of the

columns and of the intervening walls is the same (7½ ft.), so that half of the wall area is made up of columns and half of curtain wall and window space. At the tops of the columns the flanges of the "channel" are filled between with a bracket girder reinforced on the bottom face. The ends of these girders are molded with pockets to receive the ends of the afore-mentioned I-beams which span the space between columns and which form, together with the bracket girders, a continuous runway girder for a bridge crane track.

The economical construction of the forms is based on two things—first, the uniformity of the design of the wall, which allows of the same form being repeatedly used, and, second, the use of large and heavy forms which must necessarily be moved by power, thus ensuring a rapid and cheap method of erection and dismantling. If time permitted, the construction is such that three forms only would be needed, viz.: for the column footing, the column proper and the curtain wall. In the actual work on the one building of the plant which has been completed for 80 footings and columns and 78 curtain wall slabs only ten forms of each kind were used. In other words, each form was used eight times and shifted seven times.

In this forming (see Figs. 3 and 4) the two points of interest are the simplicity and the size.

The form for one entire column is in four pieces, the back and two sides being plain panels and the front a trough-shaped panel forming the channel space and the edges of the flanges. The whole is tied together with cross-battens having slotted ends which carry tie-bolts.

The front panel in the column form is a piece weighing 5,000 lbs., and although it is the heaviest piece used, the others are too large to permit of easy handling by manual labor. For the placing and removal of the forms the device shown in Fig. 5 was therefore used. It consists of a rigid A-frame mast mounted on wheels and carrying at the bottom an electric crab. In operation the frame travels along a plank runway inside the building. It is guyed both in front and back to ropes running parallel to the wall between deadmen set about 50 ft. apart. This guy system allows of the movement of the frame from column to column with much less difficulty than would be experienced if a separate pair of deadmen were used for each set-up.

In erecting a column the footings are first cast with their tops leveled off accurately by a layer of mortar shaped by a special form, so as to make a tenon of just the shape and dimensions of the bottom of the column proper. The A-frame is set directly in front of the footing and tilted so that the top of its mast comes vertically over the column. The heavy front channel piece of the forming is swung into place by the A-frame, next the back piece, and, finally, the two sides. The form is then bolted together, and, fitting into its correct position in the tenon already cast, is plumbed by any convenient guy-line method.

In removing a form the same method is reversed and the process carried on in a very short time. On the Plainfield work about 30 minutes were consumed in shifting the A-frame and removing the form from a column, working five men, including the crabman.

The work was carried on by first erecting the footings in groups alternately on either side; then, when the footings had been placed, following with columns, and, lastly, after all previous forming had been removed, building the curtain walls into the grooves in the columns. The whole was laid up in a 1 : 3 : 5 concrete, the aggregate being crushed very small, in order to get a solid, non-porous wall in the thin sections.

For the information from which this description has been prepared we are indebted to the Ransome Concrete Machinery Co., of New York.

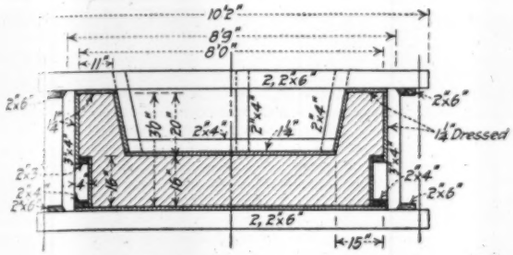
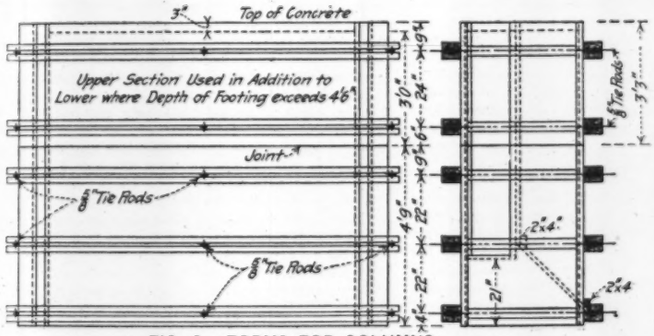


FIG. 3. FORMS FOR COLUMNS.



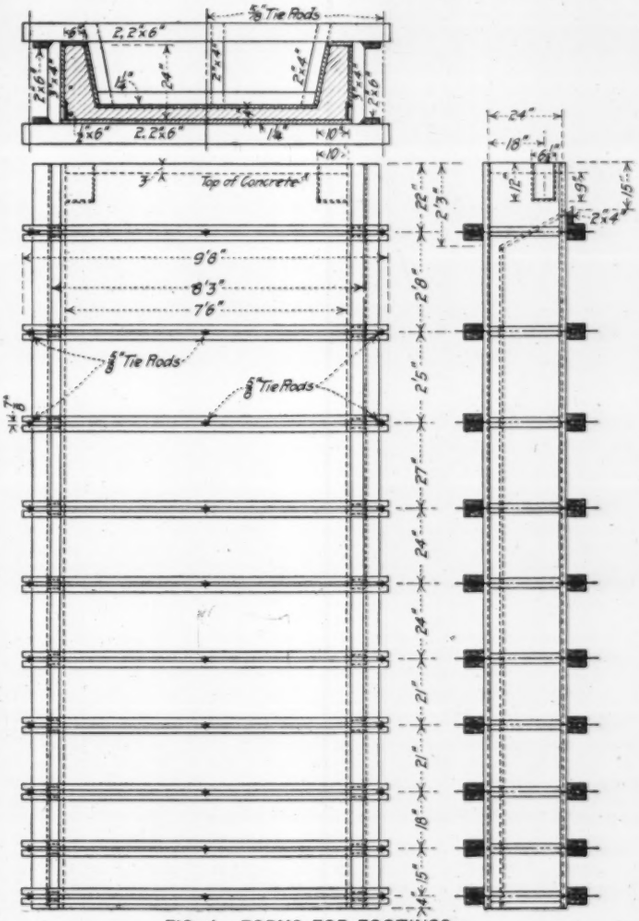


FIG. 4. FORMS FOR FOOTINGS.

FIGS. 3 AND 4. FORMS FOR WALL CONSTRUCTION IN REINFORCED CONCRETE BUILDINGS AT PLAINFIELD, N. J.

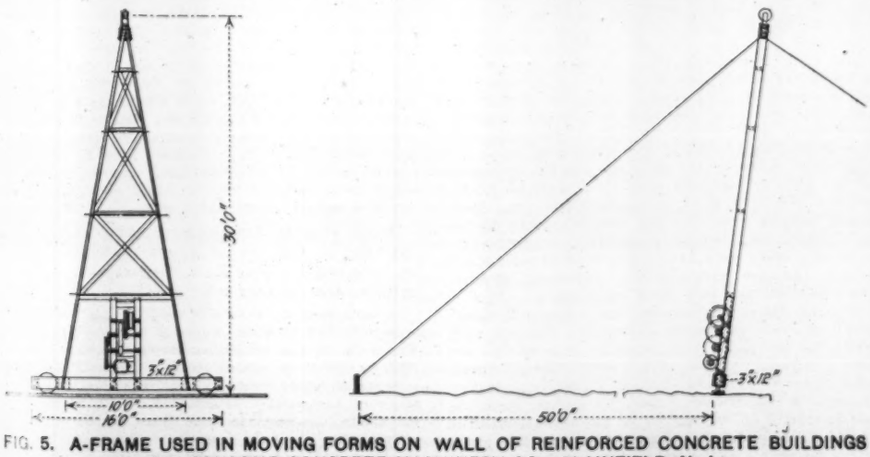


FIG. 5. A-FRAME USED IN MOVING FORMS ON WALL OF REINFORCED CONCRETE BUILDINGS FOR RANSOME CONCRETE MACHINERY CO., PLAINFIELD, N. J.

A CAVE-IN at Bingen, Germany, buried some 40 workmen Jan. 4. The accident occurred in the cutting of a new railroad between Lamscheid and Leiningen. An embankment had collapsed, burying two men, and a large force of laborers was immediately set to work to dig the buried men out. While thus employed a second land slide occurred, burying most of the rescuers. A large force of workmen was sent from nearby villages, and, according to last press dispatch, 13 bodies and 15 injured workmen had been removed, while some 15 other laborers were unaccounted for, and were probably buried beneath the fallen earth.

THE USE OF SULPHATE OF COPPER IN FILTRATION.*

By Dr. Adolphe Kemna.†

In Vol. IV. of the Transactions of the British Association of Water-Works Engineers the author has dealt with one class of the troubles which beset the filtering engineer, and has enumerated a formidable array of animals and their wily ways of playing mischief; but, on the whole, they are relatively easily controlled and cannot do real harm. Things are more serious with floating plants, as they cause odors and taste. From a hygienic point of view, there is not the slightest danger in a water rendered unpalatable from this cause, but at times the taste is so pronounced as to be nauseous, and interferes with the normal consumption, so that people will turn to any other water which they can secure. The danger in that case is that shallow wells and other sources of doubtful quality may be the only alternative available.

As already pointed out in the paper of 1899 a growth of fixed organisms is not necessarily a cause of pollution. Even when the bottom and sides of a big reservoir are thickly covered with growth, the amount is small in comparison with the bulk of the water. Some fifteen years ago, in various places, odors and taste were attributed to Spongilla, the fresh water sponge, which gives off a most offensive odor when decaying in a bottle or in a small aquarium; the real cause was probably floating algæ, which were overlooked at the time. Floating organisms are not limited to a plane, their area is not a square but a cube, they can utilize also the third or vertical dimension of space. They occur sometimes in astounding numbers, several thousands per cubic centimeter, and although they are generally microscopic and some of them very small indeed, still they may be sufficient to impart a deep green color to the water.

The protoplasm, sarcode, or living matter is somewhat heavier than water, therefore all organisms must go to the bottom. A dead fish floats at the surface belly upwards, and a drowned animal after a few days rises to the surface on account of the gases evolved by putrefaction. With the microscopic plants also, the greater weight of the protoplasm is counteracted by secreted fatty substances of oils, which can be seen under a high power as small globules or drops, and unfortunately these are essential oils. When the organism dies and decays these oils are liberated, and thus even the smallest living organism may impart an odor to the water.

The larger the animal the easier it falls a prey to man, thus large game in Africa and India is an object for sport, and so weak in spite of their bulk that severe restrictions have been enforced to prevent their complete extinction; the wholesale destruction of the buffalo has been the work of a couple of decades. This is only the continuance of a palaeontological law which also existed in bygone geological times. There is in the progressive phylums or clans of the animal kingdom a general tendency to increase of size; but excess is the highway towards extinction, and nearly all the huge monsters are now specimens in our museums and no longer run wild in prairie or forest.

Smaller animals, under favorable circumstances, are much more prolific and difficult to keep within bounds, and may become very troublesome indeed; as, for example, rabbits in Australia and California, rats in seaports, so dangerous in their tendency to disseminate plague germs, and mosquitos, from their being the vehicle of yellow or malarial fevers. For all these animals, their smallness is a protection, and their numbers render them dangerous. This is exactly the case with floating algæ and protozoa in water, against which the engineer is often powerless.

There is, however, a very simple way of avoiding the evil, viz., by keeping out the light. All life is dependent on the sun; plants cannot thrive in the dark; animals have only plants for food, either taken directly, when they are called phytophagous or plant-eaters, or taken, so to say, second-hand by preying upon plant-eating animals, when the eater is called carnivorous. The sequence is as follows: No light, no plants—no plants, no phytophagous animals—no plant-eating animals, no carnivorous animals. The suppresion of light cuts the evil at the root. This, however, is easily said, but not so easily done. Sand-filters may be covered instead of being left open to the light, and, in fact, covering is necessary in places where winters are severe; but the cost is considerable, and in the case of large impounding reservoirs is, of course, utterly prohibitive.

I have made some observations tending to show that the case is not absolutely desperate. During the summer of 1904, I used sulphate of alumina, not so much as a coagulant to get rid of suspended clay, but to reduce the yellow color of the water. This worked satisfactorily, and at the same time, although the summer was very hot, practically no floating algæ developed during the first few days of the life of the filter. Later on, when they appeared in larger numbers, the filter had then done a fair share of work, and its loss of head, although not reaching the maximum, had sufficiently increased so that the filter might be thrown out of use, with the trifling disadvantage of being cleaned a couple of days earlier than it would otherwise have been.

As regards algæ, the first days are the best, because there has not yet been time for them to multiply, and they have not yet accumulated on the surface of the tank. But during these first days the rate of filtration is slow, and the speed cannot be increased until a good surface film has been formed, but if the speed of filtration is then increased, you run the risk of the algæ having grown too abundant and imparting taste. In order to get the best results, contradictory conditions are to be realized, which seems impossible. The difficulty was overcome in the following way: When a filter had been cleaned and was to be filled again, a small quantity of sulphate of alumina was added to the inflowing water, so as to give at once loss of head of a few centimeters, and encourage the formation of a surface layer; the normal speed could be given sooner without any harm to the bacterial composition of the effluent.

A very striking feature in that year (1904) was the persistency of blue algæ on the filters, and especially in the intake reservoirs; they remained in noticeable quantities till the middle of November, when they were only got rid of by a complete cleaning of the reservoirs.

What is the theory underlying these facts; that is, how are they to be explained? It must be remembered that the River Nethe, our source of supply, is a tidal river, and that the water is taken in during about 40 minutes at each tide, by large pipes passing through the bank. The solution of sulphate of alumina is added to the water as it passes these intake pipes, where the current ensures a thorough mixture. In the reservoirs, there is a decantation of 12 hours; the precipitated hydrate of alumina carries to the bottom a good deal of suspended matter, and the spores of algæ have been in that way taken out of the water which went to the filters; so that the filters showed not much vegetation of algæ, because seed was scarce. The spores were not all kept back, some having escaped, and after a few days they became numerous enough to form a growth which might have been troublesome. The spores which were kept back had been precipitated but not killed, alumina not being a toxic; and this accounted for their persistency in the reservoirs.

Although this method proved a success, it is at the best only steering between difficulties. With a very muddy water, the sulphate does various duties: precipitating, decolorizing, and keeping back spores; this multiplicity of results is worth the expense. Under the same conditions, it does not much increase working expenses to shut off a filter before it is completely worked out, i. e., blocked up to its maximum loss of head. But with a better class of water, with not much clay and no color, it means adding sulphate for a few days solely for the purpose of keeping down algæ, and shutting off a filter after a week when the normal life is several weeks, thus involving a high percentage of increase in the cost of cleaning.

The hydrological event of the year 1904 was the publication on May 7 of Bulletin No. 64 of the Bureau of Plant Industry at Washington, which showed that sulphate of copper in proportions of 1 part in several million parts of water kills algæ without the least injury to higher plants or animals.

Some 30 years ago, most text-books of botany mentioned an experiment of Raulin, that the common mold Aspergillus niger did not vegetate and thrive in an appropriated nutrient liquid in a silver dish, although chemical analysis failed to detect any trace of the metal in the solution. The fact was curious, but did not create much sensation, and remained isolated. When the celebrated botanist of Munich, Carl Naegeli, died some ten years ago, a big memoir ready for the press was found among his papers which recorded the following results:

Spirogyra was killed by an ultradilute solution of nitrate of silver (the unit with 19 noughts) and chloride of mercury was still more active. If a copper coin had laid in a glass vessel for a certain time, even after having been rinsed with water, that spot remained free of growth of Spirogyra, while all the other parts of the vessel were covered with algal threads. The histological action had been fully gone into, viz., the changes in the protoplasm of the cells, as compared with those produced by the ordinary and much more concentrated solutions. These results were so astounding that Naegeli's pupils did not dare publish them without confirmation by further experiments, which were carried out by Schwendener and Cramer, and gave positive results. This action of ultradilute solutions has been called oligodynamy.

Whereas Raulin's experiment with silver and Aspergillus niger was an isolated observation, Naegeli's work multiplied the facts, went carefully into details, and gave a systematic record. For a really scientific knowledge, however, something more is wanted, viz., the explanation of oligodynamic action—the physics, chemistry, and mechanics of the reaction on the protoplasm which brings about death. Of course, Naegeli was fully aware of the desirability of this knowledge, and that is why he gave so much attention to the histological ch[illegible]; he also took into consideration the possibility of [illegible]rmal and electric actions, but was unable to come t[illegible]finite results. This is not to be wondered at, as [illegible] no better off in this respect than we are in the ca[illegible] most other toxic actions; we know what kills, but [illegible] why and how it kills. Hoppe-Seyler's beautiful e[illegible]ation of the mechanism of carbon monoxide poison[illegible]ands almost unique in science.

Thus, starting with a primary casual observ[illegible] fol-lowed by systematic research, we now come t[illegible] third phase, viz., applied science, which turns the [illegible]ific knowledge to practical results. This has been [illegible] work of the Washington Bureau of Plant Industry.

[The author here summarizes that po[illegible]n of Bulletin 64, mentioned above, dealing [illegible] re-turns from water departments on tast[illegible] and odors in reservoirs, also the brief remarks [illegible] the bulletin on covering reservoirs, strippin[illegible]ites, etc., as means of preventing tastes and [illegible]ors. He then continues:]

This chapter [on remedial measures] is only a little over one page in length, and it would serve a useful purpose to go a little more fully into the theory, so as to explain why all these methods failed and how some of these failures could have been anticipated and a good deal of money saved. We have to deal with plants and the general principles of plant physiology govern the whole question. Now it has become general knowledge that plants take as food mineral matter; they can build up living substance out of nitrates and ammonia compounds which supply nitrogen, and out of carbon-dioxide which supplies the carbon; chemically, or rather thermo-chemically speaking, these are endothermic reactions, converting actual into potential energy, the actual energy converted being light, the sun's rays; another requisite is heat, life depending on a certain range of temperature. The necessary conditions are: nitrogeneous inorganic compounds, carbonic acid, light, heat, and, as there is no such thing as spontaneous generation, a certain number of organisms to start with and to act as seed.

When several conditions are absolutely required for a certain effect, it is generally easy to interfere, as it is necessary to keep down only one of these conditions to make all the others powerless. But on closer examination, this optimistic view does not hold in the present case. The conditions mentioned are forces of nature, over which the engineer has little or no control. The very minute spores of most of these algæ are carried away by the wind, disseminated by birds, and it is practically impossible to keep a large expanse of water free of them. The whole soil is in reality an immense nitrifying apparatus; carbonic acid is a normal constituent of the air; the high summer temperature is the result of meteorological or astronomical conditions. The exclusion of light is the only thing which is more or less within reach, and also the only one which has proved efficient, and it seems as if the physiologists of the Bureau somewhat underestimated its value. When the whole watershed is unavoidably and constantly at work supplying the water with nitrogenous matter and forming this into those combinations most readily absorbed and assimilated, the influence of the bottom of a reservoir dwindles into insignificance, unless very polluted indeed, and large expenditure on this item should not be incurred without careful consideration. Injecting air may prove efficacious in taking away a large percentage of the offensive smell, but at the same time it replenishes the stock of carbonic acid and so favors further growth; it should be only applied at the moment the water leaves the open air to enter on its career in the dark, where no further growth can take place. It is therefore clear that, practically speaking, we cannot prevent the algæ from growing and we cannot protect the water from their bad influence.

The only way is to kill them, and the only way of killing them is murder by poison. The physiologists of the Bureau have not examined all the toxics, because the most cursory investigation shows that a good many of them are obviously useless in connection with public water supplies. The toxic, while it must destroy the algæ must not harm higher animals and plants; therefore fish were constant but probably unwilling contributors to the experimental work. The substance must be cheap and readily applied by unskilled labor, and as sulphate of copper alone complied with all these conditions, it was therefore further experimented with.

[Here various American experiences and discussions on the use of copper sulphate, chiefly as reported by the U. S. Department of Agriculture, are summarized.]

As mentioned on a former occasion, algæ were only present in the Waelhem works of the Antwerp Water-Works Co. in small quantities during the years 1904 and 1905, so that there was no occasion then to resort to the sulphate of copper treatment, but in August, 1906, after the very hot weather experienced at the beginning of the month, the water in some filters turned green, and after running about six days, the filters showed traces of free ammonia, and some faint indication of taste. Al-

*Abstract of a paper read before the British Association of Water-Works Engineers, December, 1906.

†Direktor Antwerp Water-Works Co., Antwerp, Belgium.

though this was hardly perceptible, the filters were then stopped and cleaned in order to be on the safe side, although they could have run several days longer. It appears that with a certain amount of growth of floating organisms there is, after a few days, an accumulation of decaying matter on the surface of the sand, which contaminates the water and impairs the purifying action of the normal bottom-dwellers. This organism proved to be Eudorina, which is a Flagellate, the cell having a whip-like thread, constantly lashing to and fro, and serving as a propeller. Generally these organisms swim with the wide or flagellum forwards. In the case of Eudorina, there are two flagella, equally long, to each cell. The Flagellates are a very extensive group with a great variety of forms, some of them being colorless, and taking as food still smaller organisms such as bacteria or organic particles. At the base of the flagellum, in the envelope, or cuticle or denser protoplasm which covers the body, there is a permanent opening, and as the food is introduced here, this opening may be called a mouth. From the organic nature of the food, its being taken as morsels and introduced in the body, and the absence of coloring matter, the Flagellates are true animals. Being dependent for their sustenance on other animals or plants, and therefore unable to multiply rapidly in the absence of such food, they must be regarded as a consequence rather than a cause.

But a good many Flagellates are green, their coloring matter being the chlorophylle met with in plants, which enables them to live like plants, and with the aid of the sun to thrive on dissolved nitrogeneous compounds and carbonic dioxide. Their nutrition is holophytic, which simply means completely plant-like. A mouth is, of course, of no use to them, and, although often absent, it is found in a more or less elaborate condition in many species. Applying the Darwinian principle of evolution, the occasional presence of a mouth signifies that the colorless swallowing organism represents the primitive condition, the ancestor, while the holophytic method of nutrition is merely a change of behavior, an assumed habit, and the chlorophyl coloring is a secondarily acquired character. The holophytic method of nutrition practically classes these organisms as plants which can multiply rapidly under favorable conditions.

Flagellates, like most other lower and primitive organisms, multiply by division. One individual cuts himself in halves and the various individuals resulting from these divisions may completely separate, or, as with many species, remain more or less connected together in the form of a colony.

A comparative study of floating organisms, both marine and from fresh water, has revealed some striking similarities in organisms differing very widely in regard to their general structure. These identical characteristics must therefore be considered as having been acquired owing to similarity in the mode of life. Thus a marked tendency to spherical form may be considered as a result of uniform relation of parts with an homogeneous environment, and a tendency to increase of bulk by gelatinous secretion as a means of ensuring buoyancy. Eudorina is a spherical mass of glassy jelly in which are inserted a certain number of green cells, with the two flagellæ projecting free over the surface; these cells or individuals are well apart and not in contact with each other.

Turning now to Bulletin No. 76 [U. S. Dept. of Agriculture] a table is there given showing the relative sensitiveness of various organisms, which it is important to consult to know how much sulphate of copper is necessary to get rid of a given species. Eudorina is mentioned in this table, but unfortunately, being of the most resistant organisms, it requires 1 part of sulphate to 100,000 parts of water. As far as could be inferred from the published data, this great resistance is unusual; but a near ally, Pandorina (which may be described as an Eudorina with close-set cells), is also given with the same figure. Although the authors say "that there is absolutely no possibility of correlating the effects of copper on related forms," still it seems that the fact of the two most resistant organisms being genera so nearly alike is not a mere coincidence. Only one other form of green flagellate is mentioned in the table, the genus Euglena, which may be considered as more normal and typical, being composed of single individuals not grouped into colonies, and without a jelly; its resistance is given as 1,500,000, and this also seems a more normal figure; thus while the normal green Flagellate Euglena has only a moderate resistance, the colonial forms with a gelatinous envelope, Eudorina and Pandorina are 15 times more resistant. This at once suggests the possibility that the greater resistance is due either to the grouping into colonies or to the protective jelly.

If we now refer to the table in the light of this suggestion, we find at once a certain number of interesting facts. One of the most dreaded of odor-producing organisms is the blue alga Anabæna, the one which gives the "pig-pen" odor. It is a colonial organism, a series of round beads either in a straight string, or in beautiful spirals or coils; it is extremely sensitive, being killed by a 10 million dilution. The genus Aphanizomenon is very much the same, the only differences being unimportant structural details. Both generas have no slime nor jelly, are naked, and the high sensitiveness is in accordance with this unprotected condition. The most striking difference is that the threads of Anabæna are isolated, while those of Aphanizomenon are grouped into comparatively huge masses, visible with the naked eye, and looking like finely chopped grass. The resistance of Aphanizomenon is given as 5,000,000, double that of Anabæna. Thus the protective effect of crowding becomes very evident in this case.

The action of a gelatinous envelope is also well emphasized by comparing Eudorina and Pandorina with other colonial Flagellates where the individual cells are not embedded in a common matrix. Synura is such a form, and its resistance is much less, a solution of 1,000,000 to 3,000,000 being sufficient to kill.

Two other colonial Flagellates have been experimented upon: Volvox at 4,000,000 and Uroglena at 20,000,000. These results are aberrant, as these organisms have a gelatinous envelope; but they present peculiarities which may account for their higher sensitiveness. The gelatine is not a massive sphere, but a hollow shell, the interior of which is occupied by a liquid; the cells are embedded in that comparatively thin shell, and those of Uroglena even project over the general surface; this last genus moreover is known to be extremely delicate, the colony easily breaking up.

With such complications as generally prevail in biological problems, and our comparatively scanty knowledge, we cannot expect to explain everything, but one thing is certain—viz., that the specific resistance must be the result of specific organization, either chemical or morphological. The chemical side of the question is at present absolutely out of reach, but the morphological aspect of the matter is practically covered by micrography, and here we do know something. It thus becomes quite possible to bring that morphological knowledge to bear upon the physiological facts with a view to determining such characteristics as are coincident, and then ascertaining whether there is not a logical relationship between effect and cause. The above considerations show that in some cases it is possible to get some insight into the phenomena, and that a scientific understanding is not such an utterly hopeless thing as the able physiologists of the Washington Bureau have represented it to be.

To return to my own experience at Antwerp; as Eudorina was multiplying in my filters, and threatening to become noxious, I decided to apply sulphate of copper in a dose of 1 per 1,000,000, calculated upon the quantity of water above the sand, plus that contained in the sand, which was estimated on a porosity of one-third, and the amount of water to be delivered into the filter. The water was first lowered in the filter to 1 ft. above the sand; the required quantity of the salt was dissolved in a cask with a tap at the bottom, which was placed over the inlet, the tap being regulated so as to give the necessary proportion of the salt. The inlet to our filters being an open channel with steps forming a cascade, a thorough mixture was easily obtained. Only one filter was used for this purpose, so as not to interfere with the general supply. Filter No. 4 had been cleaned on July 30 and filled and restarted on the 31st. On Saturday, Aug. 4, the plankton net showed a marked development of Eudorina and Rotifers although the effluent was good, and only a faint trace of taste could be detected. The sulphate was applied at 4 p. m., and after 36 hours the result was most marked; a haul with the plankton net showed only a few organisms, and contrasted strongly with the rich vegetation in the other filters. As, however, there had been a sudden increase of the loss of head, and the effluent showed traces of free ammonia and a very slight taste, the quantity of sulphate of copper was then reduced by one-half (1 part to 2,000,000), and on the following day (Tuesday, Aug. 7), although the organism had again diminished, the free ammonia was on the increase, and the taste a little more marked, so that the effluent was turned to waste into the intake reservoirs, the filter still being kept going.

As soon as the slightest trace of taste had appeared, the speed of the filter had been diminished to 5 cm. per hour, as a precautionary measure. The loss of head showed only a small diminution and remained practically constant from Sunday till Thursday, when it began to increase. At the same time there was an improvement in respect of free ammonia and taste, so that on Sunday, Aug. 12, it was considered quite safe to again utilize the effluent, the filter was turned on the clean water tank, and the sulphate of copper stopped. The loss of head increased rapidly, and on Thursday, Aug. 16, the filter was shut off for cleaning.

During the first days of its life, although the loss of head was nil, showing the absence of a film, the bacterial results were excellent. The sulphate of copper treatment coincided with a pullulation of microbes, the plates of three successive days being rapidly liquefied, those of Thursday, Aug. 9, showing 10,000 colonies; but the next day the figure had diminished by 90%.

When the filter was restarted on Saturday, Aug. 18, there was for three days some free ammonia in the effluent, and for ten days there was no loss of head, and, although speeds of 7 and over 8 cm. per hr. were allowed, the bacterial results remained satisfactory.

The following table gives the daily working results of this filter:

Date.	Head.	Speed.	Microbes.	Remarks.
July 31.	0	1.5	8	..
Aug. 1.	0	5	34	..
" 2.	0	8	24	..
" 3.	2	11	14	..
" 4.	6	9	34	CuSo4 1/1 (6)
" 5.	17	9	..	" "
" 6.	17	5	..	" 1/2 (6), taste NH_3
" 7.	16	5.3	..	" "
" 8.	16	5.5	..	Plates of 6 to 8 liquefied
" 9.	17	5	10,000	Effluent wasted
" 10.	21	5	1,085	..
" 11.	32	5	1,375	..
" 12.	37	4	..	Effluent to clean water tank
" 13.	64	5	320	Sulphate stopped
" 14.	86	5	160	..
" 15.	90	4	..	..
" 16.	120	2	6	..
" 17.	..	..	..	Filter cleaned
" 18.	0	1	200	NH_3
" 19.	0	2.3	..	NH_3
" 20.	0	2.5	100	NH_3
" 21.	0	3	70	..
" 22.	0	7.5	120	..
" 23.	0	8.5	100	..
" 24.	0	5	36	..
" 25.	0	5	12	..
" 26.	0	5	..	..
" 27.	1	5.5	24	..
" 28.	4	8	16	..
" 29.	15	11	32	..
" 30.	35	10	30	..
" 31.	38	11	16	..
Sept. 1.	52	10	..	..
" 2.	81	6.5	..	..
" 3.	120	3.5	..	Cleaned

Filter No. 4.—Loss of head in centimeters—Speed in centimeters per hour; normal speed according to Koch's rule 10, yielding 2.40 meters per day—Microbes per cubic centimeter on gelatine plates, counted after 3 days.

We may now reconsider the facts, and see how they can be explained and what they teach.

First of all, we have the rapid destruction of organisms, and especially Eudorina. Instead of being able to stand a dilution of 100,000, it was killed by 1 in 1,000,000. This organism is therefore not at all so resistent as the investigations of the Washington Bureau seemed to indicate. Another unexpected result was the disappearance of most crustacea. Daphnia were numerous on the filter; but the sulphate of copper dealt also very efficiently with them. These animals seem well protected by a carapace. They have no tender parts, such as ciliated tentacles; and it is difficult to understand how they can be so sensitive. It is improbable that in so short a time they should have died from starvation. All the organisms killed went to the bottom of the filter and settled on the top of the sand, thus causing an increase in the loss of head from 6 to 17 cm. As the same fate attended the plankton of the water constantly introduced from the reservoirs, the loss of head ought to have increased, and certainly would have done so had not the speed of filtration been lowered from 9 to 5 cm. per hr. These two contrary actions seem to have balanced each other, and the loss of head remained constant.

There is probably also another cause at work. It is very remarkable how rapidly most of these organisms disappear by decay; this is probably why the Baltimore bacteriologist missed Anabæna. This rapid destruction must tend to restore the permeability of the filter and perhaps the small diminution of the loss of head on Aug. 7 might be explained in this way. As a further result, it is seen that decay will produce ammonia and give rise to or at least be accompanied by a pullulation of microbes; and all these logically connected phenomena have occurred in due time; on Aug. 5 immediately after starting the sulphate treatment, increased loss of head; and the following day when putrefaction had set in, ammonia and plenty of microbes; still more of these on Aug. 7 with a small diminution in the loss of head. In some of the reports to the Bureau, a temporary increase in microbes has also been noted.

It has already been mentioned that on disintegration these organisms liberate their perfume. And again we see the taste showing concurrently with the other phenomena. Whether in this case the smell and taste were chiefly due to the floating forms is not quite obvious. There was already a growth of Oscillaria on the sand and this may have contributed to produce this.

Bacterial analyses would be an excellent guide if they did not come three days too late; thus on Aug. 6 the appearance of ammonia and taste induced to a reduction of speed, but when the bacterial results of that day were known (on the 9th) the water was at once turned to waste. On the 12th the water being better, the plates of the 10th were examined, and although not fully developed, they showed that there was a diminution in microbes also, and it was decided to again turn the effluent into the clean water-tanks; and the analyses of the two following days showed that this was right. Each filter when cleaned is subjected to a biological examination. This examination was in the present case of special interest, as there was a striking difference in the results obtained with the other filters cleaned during the same period both in the total absence of blue algæ and the general poverty of the film.

Only the diatoms had stood the treatment fairly well, and there is no doubt that a smaller dose, still sufficient to deal with Flagellates, would have left the diatoms unaffected.

The author paid some attention to the modifications brought about in Eudorina. The individual cells of a colony behave very differently, and of course it is not possible to follow the changes in one and the same colony, but from the various specimens obtained at different stages of the operations a well graduated series can be made out, and the probable sequence of events surmised. It seems as if in each colony some cells, being weaker than the others, were more quickly affected, losing their shape and color, and shrinking to a small mass of dull greenish granules; while other cells remained unaffected. There are all the links between a full grown colony with its normal 32 cells and colonies with only a few, sometimes only a couple of cells. The volume of the whole mass diminishes while the destroyed cells disappear completely and the gelatinous mass readjusts itself, always keeping its spherical form, although being sometimes more or less distorted.

The author has also shown in the table the details of a second period of life of the same filter, because they show some interesting facts. The presence of a marked quantity of ammonia in the first effluent is quite exceptional. Generally this is the best water, as it has remained so long in contact with the sand. For that reason the author has for several years departed from the ordinary practice in collecting the water. Although no difference was indicated by the analyses of the last days, the author, being on unknown ground, had hourly tests made for ammonia (they take about a couple of minutes) and when the ammonia was found to be increasing, the water was diverted into the intake reservoirs. After three days, all being right again, the water was utilized. The bacterial results showed that it was wise to shut off from the clean water tank, and also that the utilization of the effluent was resumed at the right moment.

A very noteworthy fact is what may be called the after-effect of the sulphate of copper. When the filter was restarted after cleaning, although no sulphate was added, the loss of head remained nil for ten days. After the second, third, and fourth cleanings, the same effect is still noticeable, and at the moment of writing (Nov. 8) the curve of the loss of head of that filter (No. 4) still contrasts with all the other filters. It seems as if there were a greater difficulty to start growth, although the biological examination of the surface layer when cleaned shows no difference from that of other filters. The copper salt does not remain in solution; there are various causes of precipitation, and it is possible that the grains of sand get coated with a layer of precipitate, just as they get coated with iron. This may be of some practical importance, but requires further investigation.

There is, however, no denying the fact that the first effect of sulphate was to make things worse; the filter was bad during at least six days. As already stated, this was only to be expected, and the procedure with filter No. 4 was only considered as a preliminary experiment. After three days sufficient evidence was available to show that the treatment ought to be applied not on a water already highly charged with plankton and as a cure, but on water in a medium condition and as a preventive of the pullulation of organisms. Therefore the old filters were left alone, and as the cleaned filters were restarted, they received sulphate in the proportion of 1 in 2,000,000. Three filters were so treated, one during nine days, another during four days, the last one during one day only. In the meantime the temperature had become more moderate, growth was on the decline, and the sulphate was stopped. The effect was still very marked on life, there was scarcely any ammonia, practically no taste, and only with one filter for a couple of days were there more microbes. There is not the slightest doubt that the use of sulphate was a great help in maintaining the excellent quality of the filtered water, with a very bad source of supply, during a spell of exceptionally hot weather and of maximum consumption.

As far as the author knows, there is no other record of the application of sulphate of copper to ordinary sand filtration, and as the experience given herein may prove of interest to others, the author has gone somewhat closely into details, which may perhaps explain and atone for the length of this paper.

The use of sulphate of copper in water supplies is an excellent illustration of the relationship which ought to be established between theoretical science and practical application. There is no doubt that it is the outcome of pure scientific research, but as such it remained confined to scientific circles. Naegeli never dreamt of water-works, and the engineering profession is not much to be blamed that they have not unearthed his paper on oligodynamy from the proceedings of a Swiss scientific club. If it were contended that, on the one hand, Naegeli should have sought for practical applications and that, on the other hand, the engineer should not have remained ignorant of his research, then we have a case where what is everybody's business is nobody's business. There should be in our social organization an institution whose special function it should be to bring the two into contact. The boards of health in America and elsewhere have accomplished much in this direction, and the good they have done cannot be overestimated; but sometimes they incline a little too much towards the purely scientific side; what they recommend is not always easy to carry out, and this makes the engineer distrustful of all these novelties. What is being done at present in Germany to place sand filtration under scientific control serves no useful purpose. A marked feature of the Washington Bureau is its scientific thoroughness and its eminently practical turn of mind. The readiness of water engineers to be helped, their willing collaboration to apply and investigate scientific processes is a credit to the profession at large and has certainly been to the mutual benefit of both scientists and engineers.

DISCUSSION.

[The lengthy discussion following the paper was notable on account of (1) the numerous citations, by different men, from American literature on the use of copper sulphate; (2) the leaning shown towards the occasional use of copper sulphate, on the one hand, and, on the other hand, extreme conservatism as to its use; and (3) references to several instances where copper sulphate had been used in England. Below we present, much condensed, the report of the discussion that appeared in the London "Surveyor" for Dec. 14, 1906.—Ed.]

Mr. W. H. Humphreys (York) said that for the past two years his company had been troubled during the summer months with a growth of algae on its filter beds. Fortunately there was nothing particularly objectionable, so far as smell was concerned, but the growth was so very rapid that it speedily blocked the filters and caused them to be laid off for cleaning. Although America might claim to be the first to put copper sulphate to practical use in a water-works, its use as a germicide was recommended in connection with the water supply of Hamburg by a German chemist named Kröhnke, just after the epidemic of cholera in that city in 1892. But the German water engineers were not willing to give their consumers copper sulphate in the quantity stated to be necessary, and that was the very point of caution he would urge on English water engineers to-day. Copper sulphate, or blue vitriol, they all knew to be a poison. Fortunately, he thought its use in this country with a water supply was almost non-existent. He was quite satisfied that the results stated by Dr. Kemna and others were proof that the growth of certain objectionable forms of algæ could be prevented by the use of copper sulphate, but he was not satisfied with the means; and when the author told them that the only way to get rid of algæ was to kill it, and that the only way to kill it was murder by poison, it seemed to be introducing an element into a water supply at, in his opinion, some considerable risk.

Mr. F. R. Hull (Tynemouth) observed that at Tynemouth water-works last year they had a growth of algæ in their water. He put in a solution of 1 part of copper sulphate to 1,000,000 gallons of water and succeeded in killing off the algæ.

Dr. J. C. Thresh (county medical officer of health of Essex) remarked that the conditions in this country differed very much from those with which Dr. Kemna was more particularly familiar. If insufficiently pure without the addition of chemicals, we would think they were insufficiently pure to use at all. He took it, however, that Dr. Kemna only contended that copper sulphate might be used on occasions with advantage, but these would be very rare indeed. Sometimes a water became a little unpleasant in smell in this country, but in America it was a constant occurrence. He thought they probably might make use of the treatment in an emergency, because one could not get over the impression that a water that had an odor could be very wholesome.

Mr. E. Sandeman (Derwent Valley Water Board) related that in the autumn of 1898 he was filling a large reservoir in Dartmoor. On commencing operations large numbers of worms traveled up in front of the water, and sea-gulls came up from the sea to eat them. The summer of the following year was very hot, and although they did their best, by letting out as much of the water as they could, there was a stench which was beyond description. He was in the unfortunate position of having no other supply for the town of Plymouth, and he naturally got into a state of anxiety. At the surface of the water, which was yellowish in color, there was only a slight smell, but when one stirred it up from the bottom the smell became very great. The year being a dry and very hot one it was a very difficult matter to deal with. Ultimately, however, he decided to turn the water through an old open channel, eight miles in length, in order to subject it to the influence of light and air. This process dis[pelled] of a great deal of smell, but the color remained much the same. They had analyses made during whole of the summer of 1899, but nothing of a [de]terious nature was found. As the summer passed and more rain came the water gradually impro[ved] but for several years afterwards it retained a yello[w] appearance.

Mr. Clemesha Smith (Wakefield) said there appe[ared] to be no room to doubt that copper sulphate in var[ious] proportions would prevent the growth of numerous [algæ] which at times had been the bane of many a w[ater] engineer. Dr. Howard Jones, medical officer of he[alth] of Newport, England, obtained good results from a solution of 1 in 1,000,000, and in one case appeared have been successful in destroying algæ which g[ave] a fishy odor to the water with 1 in 10,000,000. Howard Jones found it necessary to treat a reser[voir] of some 80,000,000 gals. (96,000,000 U. S. gals.) in M[ay] after which no trouble was experienced during [the] year. Mr. H. Watkins-Pritchard, Government b[ac]teriologist of Natal, after making careful experime[nts] concluded that 1 part of copper sulphate in 100,[000] parts of water was sufficient to destroy the ordin[ary] bacterial flora of running water if allowed to act u[pon] it for 24 hours, also that 1 in 75,000 parts, or 1 gr[ain] per [Imp.] gallon, was sufficient to destroy the vita[lity] of the typhoid bacillus in an infected water with [an] exposure of three hours. Further, that in sulph[ate] of copper used in the proportions indicated, "we p[os]sess an agent which promises to be both valuable an[d] safe," and he suggested that practical trials shou[ld] be made in view of the incidence of water-borne di[s]eases upon South African communities. So far every[thing] seemed in favor of the treatment, but, like every[thing] else, it must have its limitations and its draw[backs]. There was at present a certain hesitation in the general feeling regarding copper, which he hoped would shortly be removed. The whole question was one of deep interest to all who were concerned with water supplies, and their thanks were due to Dr. Kemna for so ably bringing the matter before them.

Mr. J. S. Pickering (Cheltenham) said he was sure the information Dr. Kemna had given would be very useful to a large number of water engineers who had to deal with a water liable to self-pollution from algæ. Considerable doubt seemed to be expressed as to whether they were justified in recommending this treatment under varying conditions in this country, and those who had that doubt might be well advised in obtaining the bulletins issued by the plant industry of Washington. These were available for a few pence, and contained everything of value on the subject, secured after great research by very eminent men. He himself had to deal with a water not of the character described by Dr. Kemna or by the experts who had carried out the trials in America. It was a spring water coming from the oolite. If used fresh it was a good water, but on storing it in open reservoirs a plant growth took place, the name of which was Chara fœtida. This plant had not been referred to in the bulletins spoken of. For two or three months in the year the water gave trouble, giving off an unpleasant odor and having an objectionable taste, and it was a question whether that water supply should be abandoned or treated with copper sulphate. The subject was therefore of the greatest interest to him. For sixty years the water had given considerable trouble, but last summer they were able to pass the whole of it through a closed reservoir, with the result that for the first time in the history of the water-works there was not a single complaint as to the quality of water. Gloucester had also employed the treatment, the water there being polluted at certain times of the year by algæ. They had adopted filters with sulphate of alumina but were driven this summer to the use of copper sulphate, and treating a large amount of water in an open reservoir obtained very satisfactory results. He was glad to have the assurance of Dr. Thresh that they could make use of the treatment without fear, but the water engineer ought not to take any responsibility in the matter at all, because he thought it was entirely outside his sphere of work.

Mr. F. Griffith (Leicester) proceeded to refer to the case of certain filter-beds at his own works which became quite choked up by the presence of algæ. The stoppage was so serious that it was impossible to pass away the water from the beds, the consequence being that the reservoir was disused entirely for some time. He had also been troubled in another way, as many as 45,000 dead fish having been taken out of his reservoirs. He did not think they ought to let such opportunities pass of further investigating the subject of copper sulphate treatment, and they ought to cultivate closer ties with the bureau at Washington, and to have the reports in their library so that every member of the association might be able to consult them if required.

Mr. Baldwin Latham (London) said he did not think that at the present moment copper was the only thing that could be used. In Paris they used ozonized air

which had precisely the same effect, nearly the whole of the microbes [sic!] being destroyed and removed. For many years past they had suffered in various parts of England from the growth of the Chara fœtida, but he would very much question whether the disagreeable taste and odor were due to that particular plant, or to the smaller microbes which had been discovered in recent years.

ELECTRIC SHOVELS FOR RAILWAY AND MINING EXCAVATION.

The use of electric shovels in place of steam shovels offers several advantages where electric current is available, and a number of such shovels are already in regular use, being employed in placer mining and in gravel-pit and grading work on electric interurban railways. Among the principal advantages are the following: (1) The machine requires only two men, while three are generally employed on a steam shovel; (2) the hauling of coal and water is avoided; and (3) the fuel economy is higher. Where gangs or groups of shovels are in operation for a considerable length of time, the fuel economy of a central power plant under proper care may be very considerable as compared with that of a number of small individual boilers operated under unfavorable conditions, and subjected to more or less rough usage, besides having the several fires started up afresh every morning. It has indeed been proposed to employ electric power for the large number of shovels permanently employed in excavating ore on the iron ranges in order to secure the advantages of economy in cost of operation.

In Fig. 1 is shown a 40-ton electric shovel at work, and loading material upon flat cars hauled by an electric locomotive. The car frame of the machine is 27 ft. long and 7 ft. 8 ins. wide, mounted on Sterlingworth steel trucks with 33-in. wheels, and fitted with M. C. B. automatic couplers. The crane has a length of 20 ft. c. to c., with a height of 21 ft. 4 ins. from the rail to the point of the crane. The dipper handle carries a dipper of 1¼ cu. yds. capacity This machine will cut to a width of 26 ft. at the level of the rails, or 33 ft. at a height of 10 ft. above the rails. Chains are used instead of cables, and the drums are geared to electric motors. In this machine there is a 65-HP. motor for hoisting, one of 25 HP. for crowding the dipper forward and bringing it back, and a third of 20 HP. for swinging the crane. The machine is self-propelling, the gearing being driven from the main motor. A direct current of about 500 volts is generally used, and the machine is operated by controllers similar to those used on electric cars, but a circuit breaker is provided to eliminate any chance of burning out the motors through an excessive overload.

A smaller electric shovel of the "Little Giant" class, weighing 20 tons, is shown in Fig. 2, and this view shows the arrangement of the motors. This machine has been in use for about six years by the Milwaukee Electric Railway & Light Co., of Milwaukee, Wis. It has been employed mainly in gravel-pit work, but has also been used in general excavation and grading at points where current could be taken from the trolley wires of the railway lines. When employed for grading, a temporary pole line is sometimes built to serve the shovel. This machine has a 50-HP. direct-current motor operating a dipper of ⅝-cu. yd. capacity, and it has handled as much as 30 to 40 yds. of material per hour. Mr. Fred. G. Simmons, Superintendent of Construction and Maintenance of Way, informs us that it has been very satisfactory, and that there has never been any trouble with the machine. It is cheaper than a similar steam shovel, while it is more convenient to handle and more easily kept in repair. Its limitation is that it can only be employed within reasonable distance from the trolley lines.

Both the machines above described were built by the Vulcan Iron Works Co., of Toledo, O., which firm has a number in use in railway work and placer mining in different parts of the country, and at a maximum distance of 12 miles from a power-house. In electric railway work they have been used by the Milwaukee line above noted and by the Toledo & Western Ry., of Sylvania, O., while in addition to 20-ton and 40-ton machines already described, the company is now preparing to build several 75-ton machines for mining work in the western states. They are all practically identical with the company's steam shovels of the same sizes, except in the substitution of motors for engines, and the consequent elimination of the boiler and its accessories, and they are considered to be fully as efficient as the steam shovels in regard to work performed.

THE PRESENT OUTLOOK FOR RAILWAY TIE PRESERVING PROCESSES IN THE UNITED STATES.

By Samuel M. Rowe,* M. Am. Soc. C. E.

The increasing difficulty of procuring railway ties, and their rapidly increasing cost, are forcing attention to the necessity of adopting some methods of prolonging the life of the ties and of broadening the field of supply. The use of metal and concrete has been suggested, but it is to be apprehended that the greater cost of metal and the advantage possessed by wood will preclude the introduction of substitutes of wood for a long time to come.

While the chemical treatment of wooden ties has been resorted to in this country for a comparatively short time and only in isolated cases, enough has been learned to demonstrate its value and its economy, and also to prove its adaptability to a great number of timbers that are not suitable for tie purposes unless treated. It has thus materially extended the field of the available supply of tie timber. Many tentative efforts in this direction have been made in this country during the last half century, by the introduction of various processes and the use of various preservatives, but owing to the abundance of the best quality of tie timber there was but little progress made for many years. Under present conditions, however, self interest is compelling attention on the part of the railways, and no one subject connected with railway maintenance is being more generally discussed than that of tie economy and tie preservation. Not only is it being discussed, but action is being taken, and a strong desire evinced to take the best means to make the action effective.

Up to this time, two agents have been mainly employed; chloride of zinc and oil of coal tar (creosote); the latter is the most effective but the former is the most economical. Results so far in this country show that by the zinc-chloride treatment the life of the soft woods is more than doubled, giving a mean life of from 8 to 12 years for pine that if untreated usually lasts from 2 to 5 years. It must be understood that this is the mean life, the actual life being from 5 to over 20 years for the treated pine ties, as against 2 to 7 years for the untreated ties. The treatment with creosote gives perhaps 25% to 50% longer life than the treatment with zinc chloride, but at from three to four times the cost with the same timber, and with the further difficulty that many of the timbers that it may be desired to treat, can only be penetrated superficially by the creosote.

The zinc-chloride (or burnetizing), zinc-tannin and creosote processes comprise all that have been tried in this country of which we are able to offer extended and authentic records of results. These records show a mean life of 8 to 9½ years for burnetized pine tie on the Southern Pacific Ry., and nearly 12 years for pine ties on the Atchison, Topeka & Santa Fe Ry. Of ties treated with zinc-chloride in 1885 some are doubtless still in the track, in spite of mechanical wear, and notwithstanding the fact that some were prematurely removed during the recent work of laying crushed limestone ballast on a large part of the line on which these ties were laid.

Some efforts are being made to discredit zinc-chloride, and the statement is being made that the chloride treatment has been abandoned in the old countries. No reason is assigned for this, but one reason may be the cheapness of creosote oil, which but a few years ago was almost unsalable, there being but a limited demand for it. This reason, however, by no means casts discredit upon the efficiency of the chloride process. Unless the price of creosote oil can be held below present prices its use cannot be economical for railway ties where 10 to 15 lbs. per cu. ft. are required, and even twice this amount is sometimes absorbed by the softer pines. In case where piles are treated, especially for use in salt water to protect them against the teredo, the largest amount is justified.

There is no question but that creosote oil is a valuable agent for tie preservation. My attention was called recently to a case where Southern short-leaf pine ties were treated with creosote in 1880-82; and nearly 7% were still in service

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FIG. 1. A 40-TON ELECTRIC SHOVEL AT WORK ON AN ELECTRIC INTERURBAN RAILWAY.
Vulcan Iron Works Co., Toledo, O., Builders.

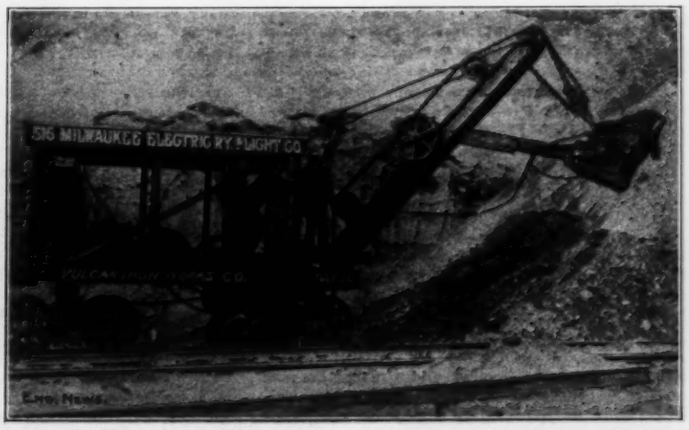

FIG. 2. A 20-TON "LITTLE GIANT" ELECTRIC SHOVEL OWNED BY THE MILWAUKEE ELECTRIC RAILWAY & LIGHT CO.
Vulcan Iron Works Co., Toledo, O., Builders.

after 24 years. Of ties treated in 1885 with zinc-tannin, 4% were still in use after nearly 20 years, and these figures seem to represent about the relative value of these two agents. It is well to remember that these soft wood ties are likely to fail under rail and spike wear in less than 12 years.

The use of these two agents (zinc-chloride and creosote) in combination opens up a newer field which is worthy of investigation, but it must be borne in mind that some tangible proofs of the results must be obtained before railway managers or others can be expected to invest the amount of capital required in plants for treating large quantities of ties. The cost of chemicals and cost of operation must also be taken into account. It would hardly be safe to assume that the reduced amount of creosote oil proposed (only 4 to 6 lbs. per cu. ft.) could be relied upon as sufficient for preservative purposes until this has been demonstrated by time and tests.

Two of these combination methods are the Rutger (zinc-creosote) and the Giussani processes. In the former, the creosote and zinc-chloride are applied simultaneously as an emulsion. In the latter, the ties are first boiled in hot creosote oil and then plunged into a vat containing a cold zinc-chloride solution. The Giussani process would seem to afford a fair treatment for ties if the absorption of the chloride is complete, but seems to be only effective as to penetration in very soft open wood. The Rutger or zinc-creosote process has been under trial for many years, and as the penetration of the oil even in red oak seems to be quite complete and that of the chloride quite as complete as in the burnetizing and the zinc-tannin processes, there is no reason why it should not rank with these other processes, and with a strong probability of even better results. I have not the records at hand to show the average life of the ties treated by this process, but Mr. Octave Chanute estimates their mean life above that of ties treated with zinc-tannin.

The Rueping process is also a process seeking complete penetration by a partial dose of oil. It is based upon the principle that the only way in which complete penetration can be secured is by means of a strong compression of the air in the wood (usually 35 to 40% of the volume of the tie), applying 60 to 80 lbs. of air pressure on the charge. Then while holding this pressure the oil is forced in by using twice the pressure until the wood is impregnated. Then the pressure is released, allowing the expansion of the compressed air to force out a portion of the oil. The result is that when 6 lbs. of oil per cu. ft. are forced in, about 2 lbs. will be returned, and 4 lbs. left in the wood. My observation shows that the softer and open grained woods are well impregnated, but that some of the more compact woods cannot be well impregnated by this process, while it is practicable to impregnate these latter woods with chloride of zinc as in the burnetizing or zinc-tannin and zinc-creosote processes.

The means taken in the Rueping process to extract a portion of the oil are the best and most effective known, but the doubt still remains as to the utility of using a limited dose of oil. When we have a few years' experience to demonstrate results we shall be better able to judge, but it would seem worth while to try it. The probability seems to be that the results should be equally good with the zinc-chlorides, at least with soft and open-grained woods.

The use of a vacuum for the removal of oil that has been forced into the wood will not result in extracting more than about 1 lb. per cu. ft., as the expansion of air compressed within the tie by the Rueping process will only force out about 30% of the oil that has been introduced. A large amount of oil can be forced in if a higher pressure is applied and the compression of air in the wood is dispensed with, but this will result in the serious injury of the wood fiber by forcing in more oil than the natural voids of the wood will hold. Immediately on removal of the high pressure the wood will commence to reject this surplus and will continue to do so until the timber returns to its normal condition. The true policy in timber impregnation is to induce rather than force permeation. This is believed to be largely effected by steaming, which is absolutely necessary in the treatment of hard woods.

The method used for securing impregnation of the timber by inducing the absorption, with a moderate amount of heat and pressure upon the solution or oil, has been quite generally followed for many years in the burnetizing, zinc-tannin and creosoting processes. It consists of (1) steaming, (2) application of the vacuum, (3) the introduction of the solution or oil. That this has been the best and most effective method seems to be quite apparent. It must be remembered that this programme has been established and practiced for the last 40 years, and that its correctness has not been seriously questioned until recently. Those who now dispute its value or propriety as meeting the physical laws and conditions seem to be either new students without sufficient experience to grasp the matter in all its bearings, or parties interested in other methods.

Another matter of importance in the preservative treatment is the steaming of the ties, and some claims are now made that the application of steam is both unnecessary and injurious, especially under high pressures. In long experience with steaming it has been shown that at pressures above about 20 lbs. per sq. in. it is injurious. It has long been known that the wood fiber can be destroyed by steam, but it has been claimed that 20 lbs. steam pressure will reduce the strength of the steamed timber 25 %. Recent and careful tests seem to indicate that the injury due to such pressure is so small that it may be safely ignored.

On the other hand, we know that the steaming forms a very essential part of the process, fitting the wood for absorption of the chemicals, heating and dissolving the juices and filling their place with expanded vapor which (with the air) is largely exhausted by the aid of the vacuum which is created after the steaming. No other agent can be used to bring this condition about so effectually. Not only this, but the fiber of the timber is softened for the time and eventually toughened, much as if the timber had been air dried for a long time. Examination of treated ties shows that the spike drives with less injury to the wood and holds better, while rail wear is very much reduced. This is believed to be largely due to the effect of this steaming.

Much has been said about the necessity of air drying or seasoning ties for several months before allowing the timber to be treated; this is conceded as desirable in some cases, but in others it is impracticable. The loblolly pine of the South and the mountain pine of Mexico rot so as to be useless in two years if not treated, as decay will commence in a week and progress to a serious extent before they can possibly be air dried. Where a large tie treating plant is in operation it is impracticable to thoroughly air dry all the ties before treating. Some ties dry in a comparatively short time, while others require much more time. It is hardly worth while to argue the matter farther, as we know that the bulk of ties treated are not all dry, and that the enforcement of such a rule is impracticable. On the other hand, there are many timbers that are more easily impregnated when freshly cut than when dried, such as the pines and fir of the Northwest as well as those of the Pacific slope. Not only can green, freshly-cut ties be impregnated, but any mixed lot can be brought to a uniform condition by steaming.

The rule of an allowable pressure of 100 lbs. per sq. in. upon the charge while immersed in the chloride solution of creosote oil has been criticised, and the assertion has been made that higher pressures will not injure the timber fiber, even up to 600 lbs. per sq. in. But 200 lbs. will come near to opening up a piece of oak and will check an ordinary railway tie. While this would not materially injure the strength of the fiber, it will cause easy parting of the wood and admission of water later, with consequently more rapid decay.

Those who are using the zinc-chloride process have been somewhat concerned by the claim made that the chloride of zinc leaches out of the timber rapidly. An effort has been made to prove this by a long-continued series of immersions in water, drying and analyzing. This showed that a small and regularly decreasing amount does wash out, but that after nearly 18 months of this testing only 28% of the amount originally absorbed had been extracted.

A revived process that is now being again promoted is that of vulcanizing, or, in other words, roasting the wood, but it seems doubtful whether sufficient heat to be effective can be employed without burning the timber. Probably the same result, namely, thorough seasoning, can better be secured by judicious steaming, which is about the only method that will guard against the burning of the fiber. In the kiln drying of timber resort is being had to the use of moist air (or what is in effect steaming under low pressure) instead of dry hot air. Much more light and experience are needed before we can judge as to the value of the vulcanizing process.

The writer has worked for many years in the interest of honest and effective work in the matter of the preservative treatment of ties, giving attention to every phase of the conditions to be met and to all the principles involved. Long and patient experiments have been conducted in relation to the several points discussed above, and it is believed that the results and opinions will be sustained by experience, although they have been subjected to some criticism. Much has been said as to a better understanding of this subject in Germany, but it is not believed that there is any better knowledge in that or any other foreign country than in the United States.

REINFORCED CONCRETE CAISSONS AND DOCK WALLS AT ROTTERDAM, HOLLAND.

In the construction of new quay walls or dock walls extensive use has been made of enormous concrete blocks, each the full height of the wall, but a plan which has been extensively followed at Rotterdam, Holland, is to make hollow forms or caissons of reinforced concrete, float them into position and then fill them with concrete. This construction is shown in Fig. 1. The caissons are 41 ft. 3 ins. high, rising 8 ft. 3 ins. above the low water line. They are founded on piling or upon a solid bed, and in some cases, as shown, are divided into two compartments by a vertical partition. This is for the purpose of economizing in the amount of concrete, the rear compartment being simply filled with sand or earth. Transverse partitions are also provided at intervals. At the water line is an offset forming a support for the upper part of the wall with stone block facing, the top of the wall being 14 ft. above low water. The face of the wall is protected by fender piling, the tops of the piles being anchored back to the ground and carrying mooring posts.

In the reconstruction of old quay walls at Rotterdam, considerable use has been made of the system shown in Fig. 2. The thin face wall and long base are of reinforced concrete, and are connected at intervals by triangular but-

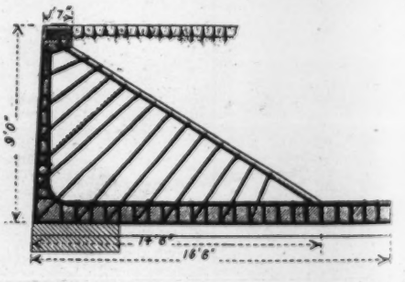

Fig. 1. Reinforced Concrete Caisson or Permanent Form for Dock Wall Construction at Rotterdam, Holland.

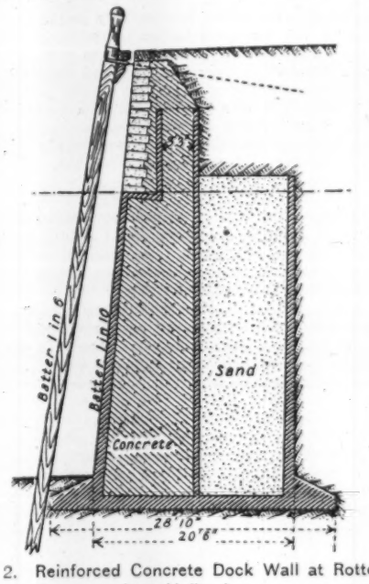

Fig. 2. Reinforced Concrete Dock Wall at Rotterdam, Holland.

tresses, in which are embedded long diagonal rods capable of taking up both tension and compression. One object of the wide base is to distribute the load over the rear piles, and to relieve the front piles to some extent, as the latter were somewhat damaged though still sound.

THE TREATMENT OF CONCRETE SURFACES.*

By Linn White.†

A pleasing and consistent surface finish generally has but little to do with the strength of a concrete structure, but it is not inconsistent with maximum strength in any structure. Next to form or design the character of the surface has most effect on the appearance of concrete whether in a building, arch, wall or abutment. In fact, when the view is had at a very close range, or in such structures as retaining walls or pavements the surface finish may take precedence over proportion. It is not intended to attempt a full discussion of the subject, but only to describe some methods used in trying to obtain satisfactory surfaces in the various classes of concrete work done in the South Park System of Chicago.

The imperfections in the exposed surface of concrete are due mainly to a few well-known causes which may be summed up as follows. 1, Imperfectly made forms; 2, Badly mixed concrete; 3, Carelessly placed concrete; 4, Efflorescence and discoloration of the surface after the forms are removed.

Forms with a perfectly smooth and even surface are difficult and expensive to secure. Made of wood as they usually are it is not practical to secure boards of exact thickness, joints cannot be made perfectly close, the omission of a nail here and there allows warping, and the result is an unsightly blemish where least wanted. Badly mixed concrete gives us irregularly colored, pitted and honeycombed surfaces, with here a patch of smooth mortar and there a patch of broken stone exposed without sufficient mortar. Careless handling and placing will produce the same defects.

But granting we have the best of labor, that all reasonable expense and care is had in making up forms, in mixing, handling and placing the concrete; that it is well spaded, grouted, or the forms plastered on the surface, the results are not satisfactory. All these efforts tend to produce a smoothly mortared surface, and the smoother the surface, the more glaring become minor defects. The finer lines of closely made joints in the forms become prominent, the grain of the wood itself is reproduced in the mortar surface, hair cracks are liable to form, and (worst of all) efflorescence and discoloration are pretty sure to appear. We surely have been working on a wrong theory. It is of doubtful efficiency to line the forms with sheet metal or oilcloth. Imperfections still appear.

Two methods suggest themselves as likely to overcome the defects alluded to above; (1) treating the surface in some manner after the forms are removed to correct the defects, and (2) using for surface finish a mixture which will not take the imprint of and which will minimize rather than exaggerate every imperfection in the forms and which will not effloresce.

Methods of treating the surface by bush hammering, tooling and scrubbing with wire brushes and water have been described, all of which have for their object the removal of the outer skin of mortar in which the various imperfections exist. But the method most used in the South Park work is the acid treatment. It consists of washing the surface with an acid preparation to remove the cement and expose the particles of sand and stone, then with an alkaline solution to remove all free acid, and finally giving it a thorough cleansing with water. The operation is simple and always effective. It can be done at any time after the forms are removed, immediately, or within a month or more. It requires no skilled labor, only judgment as to how far the acid or etching process should be carried. It has been applied with equal success to troweled surfaces, like pavements, to molded forms such as steps, ballusters, coping, flower vases, etc., and to concrete placed in forms in the usual way. It, of course, means that in the concrete facing only such material shall be used as will be affected by acid, such as sand or crushed granite. It excludes limestone.

The treated surface can be made any desirable color by selection of colored aggregates or by the addition of mineral pigments. The colors obtained by selection of colored stone are perhaps the more agreeable and doubtless more durable. There have been molded in the South Park shops blocks for buildings, columns, architectural moldings and ornaments, with both red and black crushed granite surfaces, also pavements laid in patterns with red and black granite, all treated with the acid to bring out the natural colors of the stone. There has been a large quantity of concrete pavement laid with torpedo sand surface colored a buff sandstone color with a small quantity of yellow ochre and mineral red and treated with the acid. The buff color imparted to the surface is a welcome relief from the glare of the ordinary whitish grey concrete pavement in the sunshine, and the etching of the surface adds to the softness of the color, at the same time preventing any slippiness. This same buff color has been used to a large extent in steps, bases of lamp posts, and other molded articles to be placed on or near the ground. With white sand as the aggregate, thousands of pieces have been molded for coping ballustrades, concrete seats, drinking fountains, pedestals, etc., which when treated with the acid appear like a fine grained, almost white sandstone.

Where there are projections or marks left by the molds or forms they are tooled or rubbed down before treatment, and where it is necessary to plaster up rough places or cavities in the surface it may be done and after treatment cannot be detected. These various classes of work have been done on a large scale during the last three years in connection with the improvement of new parks and has in all cases proved satisfactory.

The second method referred to for preventing or minimizing surface defects has also been tried in the South Park work with quite a measure of success. During the years 1904, 1905 and 1906 groups of concrete buildings have been erected in nine different parks costing with their accessories from $65,000 to $150,000 for each group. These buildings are all monolithic structures with occasional expansion joints, the exposed surfaces of walls being of a concrete composed of 1 part of cement, 3 parts of fine limestone screenings and 3 parts of crushed limestone known as the ¼-in. size. This was thoroughly mixed quite dry, so no mortar would flush to the surface and well rammed in wooden forms made in the usual manner. The result was an evenly grained, finely honeycombed surface, of a pleasing soft grey color, which grows darker with time and blends admirably with the park landscape. In placing, it was not spaded next the form, it was too dry to cause any flushing of mortar, so there is no smooth mortar surface, the imprint of joints between the boards is hardly noticed, and the grain of the wood not seen at all. There is no efflorescence apparent on the surface anywhere, and cannot be on account of the dryness of the mix and the porosity of the surface. The buildings are used as gymnasiums, assembly halls, reading and refreshment rooms, and as a rule the same grey concrete finish is given the interior walls as the exterior. In some cases a little color has been applied on the interior walls and the walls of shower and bath rooms have been waterproofed with plaster. The porosity of the surface makes it well adapted to receive and hold plaster.

This sort of surface is not capable of treatment with acid as a smoothly mortared surface, nor is it desirable. Consequently the only color obtainable is the natural color of the cement covered stone, but which is softer and far more agreeable than the grey of the usual mortar finished surface. It is not suited for the surface of a pavement and is not impervious to water. Although it is evident that water enters the pores to a considerable extent there is no evidence of injury from frost during the two winters some of these walls have stood. The same finish has been used for retaining walls, arch bridges, fence posts, walls enclosing service yards, etc. In the buildings, the thin walls were made entirely of this mixture while in the heavier structures it has been used only as a facing. Two reinforced arches of 60 ft. span were faced with this mixture, but the steel was imbedded in a wetter, more impervious concrete. This same dry mixture can be used for molded stones when the mold is open enough to permit tamping, and of course it is eminently suited to block machines.

The dry, rich mix with finely crushed stone has been found specially suited to another condition where a sound, smooth surface was particularly difficult to secure, viz., for the under water portion of a sea wall on Lake Michigan. It was mixed very dry and dumped in mass in sunken boxes joined end to end, made fairly water tight but from which the water was not excluded. With the finely crushed stone a sound, smooth surface was obtained (when the sides of the boxes were removed) where it was manifestly impossible to plaster or grout the surface and where spading a mix of coarser stone simply washed the cement away from the surface stones. On account of the variable water level it was particularly desired to have a sound, smooth surface.

Of the work described, most of the monolithic buildings, the arch bridges and some of the walls and paving have been done by contract. All of the molded work, the buildings made of blocks, service yard walls, etc, and all the acid treatment have been done by the park forces. Nearly all the various brands of Portland cement sold in the Chicago market have been used in varying quantities with equally good results.

In both methods described, honest work and careful inspection are as necessary for good results as in any other first-class construction. Neither method cheapens concrete work. The acid treatment slightly increases it. The surfacing with fine crushed stone adds nothing to the cost. By the acid treatment, together with rubbing and chipping, all irregularities can be corrected. With the fine crushed stone surface all irregularities and form marks are not prevented, but they are greatly minimized.

In not all the work done by the second method were the results entirely satisfactory. The original specifications called for ½-in. stone, which was afterwards changed to ¼-in. Experience taught the correct quantity of water to use for best results. But altogether both methods are so satisfactory that their use will doubtless be continued in the South Park work until something better is developed.

*Abstract of a paper read at the annual convention of the National Association of Cement Users at Chicago, Jan. 8-11. Some account of the work done for the South Park Commission was given in our issue of May 21, 1903.

†Chief Engineer of the South Park Commissioners, Chicago.

SELECTING THE PROPORTIONS FOR CONCRETE.*

By William B. Fuller.†

The growing use of concrete for structures in which great care must be taken to have only the best material and workmanship, has stimulated investigations into the effect of varying the relative proportions of sand and stone in the mix, the proportion of cement to the total remaining the same, and the result has demonstrated very conclusively that the proper grading and relative proportion of the ingredients has a great influence on the quality of the concrete produced. To demonstrate this great effect, the writer made up a set of beams 6 ins. square and 6 ft. long, varying these relations very widely from almost all stone to almost all sand, and broke the beams after 30 days with results given in the table below. It will be seen that although the amount of cement in each of the beams was the same (namely, 1 to 9 of the total material), some of the beams were over 700% stronger than others.

Proportions.	Modulus of rupture, lbs. per sq. in.	Proportions.	Modulus of rupture, lbs. per sq. in.
1 : 2 : 6....	319	1 : 5 : 3....	151
1 : 3 : 5....	285	1 : 6 : 2....	102
1 : 4 : 4....	209	1 : 8 : 0....	41

In investigating this subject over a term of years, it has been found that there is one combination of any given sand and stone which with a given percentage of cement makes the strongest concrete and this is the proportion which also gives the densest concrete, that is, the concrete which contains the least percentage of voids; or otherwise, that which weighs most per cubic foot. It is found also that this dense concrete is least permeable to water and consequently is the most durable, and it is also found that as a practical advantage such concrete is most easy to place, working easily and filling up all voids and bad corners.

The above stated law that the densest concrete is also the strongest gives a very easy way of proportioning the materials at hand so as to obtain the best and strongest concrete possible with these given materials. That is, to obtain these proportions by trial, as follows:

Procure a piece of 8 to 12-in. steel pipe about a foot long, and close one end; also obtain an accurate weighing scale. Weigh out any proportions selected at random, of cement, sand and stone, and of such quantity as will fill the pipe about three-quarters full; mix thoroughly with water on an impervious platform, such as a sheet of iron. Then, standing the pipe on end, put all the concrete in the pipe, tamping it thoroughly, and when all is in,

*Abstract of a paper read at the annual convention of the National Association of Cement Users, at Chicago, Jan. 8-11.

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measure and record the depth of the concrete in the pipe. Throw this concrete away, clean the pipe and tools and make up another batch with the total weight of cement, sand and stone the same as before, but with the proportions of the sand to the stone slightly different. Mix and place as before and measure and record the depth in the pipe, and if the depth in the pipe is less and the concrete still looks nice and works well, this is a better mixture than the first. Continue trying in this way until the proportion has been found which will give the least depth in the pipe. This simply shows that the same amount of material is being compacted into a smaller space and that consequently the concrete is more dense. Of course, exactly similar materials must be used as are to be used on the work, and after having in this way decided on the proportions to be used on the work it is desirable to make such trials several times while the work is in progress, to be sure there is no great change in materials, or, if there is any change, to determine the corresponding change in the proportions.

The above described method of obtaining proportions does not take very much time, is not difficult, and a little trouble taken in this way will often be productive of very important results over the guess method of deciding proportions so universally prevalent. I have repeatedly known concrete to be increased in strength fully 100% by simply changing the proportions of sand to stone as indicated by the above method and not changing the amount of cement used in the least.

A person interested in this method of proportioning will find on trial that other sands and stones available in the vicinity will give other depths in the pipe, and it is probable that by looking around and obtaining the best available materials the strength of the concrete obtainable will be very materially increased.

As a guide to obtaining the best concrete, the proportion of cement remaining the same, the following are given as the results of extensive tests:

(1) The stone should all be of one size or should be evenly graded from fine to coarse, as an excessive amount of the fine or middle sizes is very harmful to strength.

(2) All of the fine material smaller in diameter than one-tenth of the diameter of the largest stone should be screened out from the stone.

(3) The diameter of the largest grains of sand should not exceed one-tenth of the diameter of the largest stone.

(4) The coarser the stone used the coarser the sand must be, and the stronger, more dense and watertight the properly proportioned work becomes.

(5) When small stones only are used, the sand must be fine and a larger proportion of cement must be used to obtain equal strength.

ANNUAL CONVENTION OF THE NATIONAL ASSOCIATION OF CEMENT USERS.

The great success which attended the second annual convention of this Association, held at Milwaukee in 1906, has been fully equaled by that of the third convention which was held at Chicago on Jan. 8 to 12, 1907. The attendance at the sessions was large and it was evident that those present were directly interested in the proceedings, some for technical and others for commercial reasons. During the four days of the convention there were eight long sessions, and the attitude of the members may be gathered from the fact that while one evening had been set aside for entertainment, it was unanimously voted to hold an additional session in place of the entertainment, in order to give additional opportunity for discussion.

The number of persons registered was about 600. The meetings were held at the Auditorium Hotel, while the extensive exhibits of cement, cement products and cement machinery were at the Seventh Regiment Armory. No afternoon sessions were held, thus leaving members free to give ample time to an inspection of the exhibits. A list of the exhibitors is given in our Construction News Supplement.

THE SUCCESSES AND FAILURES OF CONCRETE.

The annual address delivered by the President, Mr. Richard L. Humphrey, M. Am. Soc. C. E. (Philadelphia, Pa.), referred to the remarkable growth and development of the cement industry during the past few years, and suggested that it is time to pause and consider the danger which may attend a too rapid pace. We give below some extracts from this address:

Cement has its weaknesses and limitations, and these should be faced squarely by its advocates in order to prevent abuse which tends to dim its excellent qualities.

In regard to the lessons of the San Francisco earthquake and fire, it is evident that the shaking and vibrations of the earth could be resisted, the secret of success being in proper design, first-class materials and honest workmanship. In tall structures rigidity of construction and stiffness, the result of adequate wind and portal bracing, is absolutely essential. While reinforced concrete structures in the zone of seismic disturbance were few, these passed the test in a highly satisfactory manner. Rigidity and stiffness and a high fire resistance which are inherent qualities of this material demonstrated how admirably they were suited to resist this extraordinary test. The types of construction represented were stone, brick and stone veneer and concrete; the latter not being reinforced except at the floor lines. The buildings of the latter type passed the ordeal successfully. The great concrete dam at Crystal Springs reservoir gave additional proof of the substantial qualities of concrete for, although within a few hundred feet of the fault line, it suffered no damage.

At Palo Alto three cement block buildings collapsed. No other result could have been expected when the method of construction is considered. The blocks were laid up without a tie of any kind and the floor joists and roof timbers either rested on or were built into wall without any tie. Under the movements of the earth the walls were pushed out of line, the wooden members of the structure not being tied to the walls, there was no means of restoring the wall to its former position and it collapsed. In one of the buildings the gable end of the roof rested against the wall and served as a battering ram.

That such structures can be so built as to withstand earthquake shocks is evidenced by a building at Santa Rosa also built of cement blocks, but differing from those just referred to in that iron tie rods held the walls tightly to the floor joists and roof timbers. While the neighboring brick, stone and frame structures collapsed, this building was but slightly damaged along the cornice line. The destruction at this point was perhaps as great as that in any part of the territory affected by the earthquake. At Mills College, just outside of Oakland, there were two structures, of concrete, one a bell tower 80 ft. high with 4-in. walls of reinforced concrete and the other a building with walls of concrete reinforced at the floor lines only. The former was not damaged in any way. The latter building was slightly damaged by the collapse of the chimneys which crashed through the roof and floors.

Wherever failures occur, it is generally cement that has to bear the blame. And on this material all the sins of omission or commission are heaped, and yet it should be noted that it is extremely rare that failures are traceable to the quality of the cement used. The failure is generally found to be due to bad workmanship, improper design, insufficient strength and a too early removal of the forms, and many failures occur from improper material, insufficient mixing, improper consistency for effective tamping.

In these days of machine mixing too little attention is given to the rigorous inspection of the process. On a large piece of work the system used in the mixing of the concrete was such that the sand was thrown in by one man, the crushed stone by another and the cement by a third; the latter being called away from his post failed to perform his part, but during the interval the sand and stone went in with rhythmic precision. It is obvious what the effect of these batches of concrete would be and how fatally they would affect the strength of an important part of the structure. In another case the cement, sand and stone were fed automatically from hoppers so adjusted as to give the requisite proportion. At the time of this inspection the cement hopper had choked, but the sand and stone were flowing on and the operator who was totally unaware of the fact, remarked, when his attention was called to it, that he thought the concrete looked rather peculiar.

Perhaps the most common cause of failure is the strength of the forms; too little attention is given to their design and they are often made entirely too light for even normal conditions and where a temporary load in excess of that for which the structure was designed comes upon it, the structure is either dangerously strained or collapses. I have in mind cases where excessive quantities of cement have been stored on the green concrete structure, in one instance producing a collapse of the floor panel. I recently saw in New York cinder concrete consisting of 1 part of cement and 5 parts of cinders going into a reinforced concrete structure.

Another source of failure is the lack of attention to details, especially as regards connections in the erection of a structure. The structure may be properly designed with the requisite amount of steel and yet may be fatally weakened by the character of the connections. A reinforced concrete structure should be practically a monolith; the tension members must be continuous in beams and columns. It makes a material difference as to the length of the splice allowed in such columns or whether the splice in continuous beams is adequate. In one instance, an enterprising laborer, observing the rod in a column projecting out of the concrete in the column of a several-story building, seized a sledge hammer and drove the bar down flush with the surface of the concrete. The remedy for all this is inspection; most careful inspection.

Plans and specifications are generally prepared by the contractor and for every skilled competent contractor, there are many who are incompetent, who do not hesitate to skin the work in order that they may finish it without loss of profit, having taken it at a figure entirely too low to admit of proper workmanship with first-class materials. Such practices are wholly unnecessary, for first-class legitimate construction can successfully compete with other forms of construction and there are many reliable concerns capable of executing such work. Owners, architects and engineers are criminally responsible where they award work to irresponsible contractors lacking in the requisite experience and knowledge for safe construction or who permit structures to be erected under the direction of competent persons who do not give the work their personal supervision.

The failure of a concrete structure by reason of improper design, bad workmanship or poor materials, is no more an argument against the value of concrete for construction purposes, than is the failure of a steel structure under similar conditions an argument against the use of steel for structural purposes. We may expect failures as long as incompetent men will undertake to design concrete structures, or unskilled men will attempt to skin the work for the sake of increasing profits. But the continual loss of life that results from these failures will bring the authorities to such a realization of their responsibilities as will result in laws which will properly safeguard the public.

CONCRETE SIDEWALKS.

The first subject taken up was that of concrete sidewalks, and Mr. Geo. L. Stanley (Ashtabula, O.), Chairman of the Committee on Sidewalks, Streets and Floors, presented the report of that committee. It appears that one difficulty in specifying mixtures for sidewalks is that both the sand and gravel used are often of poor quality, while it is often difficult to obtain sizes of gravel suitable for the purpose. Gravel averaging a ¼-in. size requires at least 25% more cement than does ½-in. gravel. Care must be taken to secure a perfect union of the top and bottom courses, and this can only be accomplished by tamping and using just enough water to allow the air in both courses to escape as the work is tamped. A paper on "Cement Sidewalks" was then read by Mr. Albert Moyer (New York), who laid stress upon the necessity of providing a properly drained foundation, with outlet for water.

In the discussion some speakers did not find any necessity for expansion joints, and Mr. Stanley stated that where the walk is cut at intervals and the cut goes through to the base or foundation, there will be no trouble from expansion. On the other hand, Mr. Wisiogel (Muskegon, Mich.) finds it best to put expansion joints 66 ft. apart, the joints being not less than ½-in. wide. As far as the foundation is concerned, Mr. Stanley considers that with good solid ground it is waste of money to excavate for a foundation course, as water will collect and the new filling will also hold water; there will be less trouble from water and frost if the walk is laid upon the surface of the ground. The extra cost in such a case had better be put into a better concrete. It was remarked that in some cases trouble has been experienced from sidewalks spreading and breaking the curbs at street intersections, but Mr. Wisiogel explained that in order to prevent this he makes a recess in the top of the curb and extends the walk across to the outside face of the curb, so that it can slide upon the curb.

The ordinary granolithic finish was condemned by some speakers, and one member spoke of using a fine aggregate and rich mixture, rolled instead of tamped, the roller leaving a roughened surface. Mr. Pearson (Baltimore) advocated the use of tile or small slabs made under pressure in a machine, as preferable to sidewalks made in place. At Cleveland sidewalk work is subject to inspection by the city, and the contractor must make a cash deposit which is held for a year to cover any repair that may be necessary within that time. This is effective in inducing the contractor to do good work, much more so than the formality of giving a bond. At the close of the discussion a resolution was passed that the Chairman of the Committee on Sidewalks, Streets and Floors (Mr. Stanley) should prepare a form of specifications; this to be printed and sent out to the members, and

brought up for discussion at the next annual meeting.

Following the President's address, a "chalk talk" was given by Prof. W. K. Hatt (Purdue University) to demonstrate in a popular manner the mechanical principles underlying the design of reinforced concrete beams.

FORMS FOR CONCRETE CONSTRUCTION; FREEZING OF CONCRETE.

This paper was by Mr. Sanford E. Thompson (Newton Highlands, Mass.), and we shall publish an abstract of it later. It showed the necessity of care in the design of forms to ensure both strength and economy.

In the discussion which followed one member described cases in which he had built foundation walls and a building in freezing weather, without heating the aggregate or the water or using salt. The concrete froze as hard as a rock as fast as it was spaded into the forms. A thaw followed soon after, and water ran out in quantities, but when the forms were finally removed the concrete was found to be solid and hard. Others spoke of building floor slabs and sidewalks under similar conditions.

The President, Mr. A. L. Humphrey, however, condemned in strong terms such dangerous practice, which will generally result in failure, and perhaps disaster. The cases cited, while apparently successful, were due to very exceptional circumstances, and it would be most unwise to let it appear that the effect of freezing upon concrete might be neglected. Freezing takes away the water needed for crystallization, and from the nature of the case cannot but have an injurious effect. He spoke with special emphasis on account of the fact that many members are non-technical men and do not understand the process of the formation of concrete by the setting of cement. To guard against failure and accident it should be made very plain that concrete should be not be laid in freezing weather, unless the necessity is imperative, and then only when due precautions are taken.

THE PROPORTIONS OF CONCRETE.

At the morning meeting on Jan. 9, a short paper by Mr. Wm. B. Fuller (New York) on "Selecting the Proportions of Concrete" was first read. This was a short and practical paper, which, as President Humphrey pointed out, gave results similar to those of tests for ascertaining the proportion of voids in the materials used, but in a more practical manner. It is printed elsewhere in this issue.

The report of the Committee on Tests of Cement and Cement Products was next read by the chairman of the committee, Mr. E. S. Larned (Boston). This recommended that all reinforced-concrete work should be made with high-grade Portland cement meeting all the requirements and tests prescribed by the American Society for Testing Materials. It also recommended the appointment of a committee on specifications, and this was adopted by a resolution. The specifications are to be printed and distributed to all members by June, and to be discussed at the next annual convention. The report contained a draft of specifications for concrete blocks.

The Committee on Laws and Ordinances submitted a proposed form of ordinance and specifications for concrete, reinforced concrete and concrete block construction. These were referred to the new Committee on Specifications, which will also consider the concrete-block specifications presented by the Committee on Tests of Cement Products. These will be harmonized and codified, and a draft submitted to all the members for consideration before the next annual convention.

CONCRETE IN ARCHITECTURE.

At the evening session, the architectural side of concrete construction was dealt with, the first paper being on "The Artistic Treatment of Concrete," by Mr. A. O. Elzner (Cincinnati, O.). It pointed out that much of this work is a mere imitation of stone; a flat surface would look better, but if a pitched or split face is desired it should be produced by chisel and hammer, as in stone work. Plain concrete walls may be relieved by bands or belt courses of decorated blocks, as is done with terra cotta. Monolithic concrete walls have many advantages over block construction, allowing of a broader and bolder treatment. But in such work there should be no use of artificial joints to imitate stone masonry. The face may be finished with a cement coat splashed on or stippled, or it may be roughened by removing the surface cement by brushes or a stream of water under pressure. The surface may be tooled with a chisel or other tool, but this is too expensive for general use. Paneling and decorative work may be secured by nailing molding strips and ornamental details to the face of the forms, as is being extensively done in Germany.

The report of the Committee on Art and Architecture was read by Mr. Charles D. Watson (Toronto, Canada). He pointed out the inartistic and unsatisfactory appearance of molded rock-face blocks. A smooth or tooled surface for the block is decidedly preferable. In his opinion, however, the solution of the problem of appearance lies in the use of a manufactured stone for the higher grades of architectural work; its expense is greater, but is likely to be reduced by the development of labor-saving appliances. The Roman Stone Co., of Toronto, is making a specialty of this class of work; the stone is cast with a smooth face and tooled by the use of a special machine carrying carborundum wheels, the surface being thus ground rather than chipped. It may also be tooled by pneumatic chisels, etc. It was stated later that the Association of Cement Manufacturers has offered prizes for designs for concrete block residence buildings of moderate cost.

THE SURFACE FINISH OF CONCRETE.

Two other papers presented at the evening session dealt with methods of giving a pleasing appearance to finished concrete. A paper by Mr. Henry H. Quimby (Philadelphia) dealt with the method described in our issue of Dec. 20, 1906. The second paper was on "The Treatment of Concrete Surfaces," by Mr. Linn White (Chief Engineer of the South Park Commission, Chicago). This described a method of treatment by acid (instead of scrubbing) to remove the cement film and leave a roughened surface; it was invented by the late Mr. Wm. Black, while Chief Engineer of the South Parks, and was described in our issue of May 21, 1903. Since that time its use has been materially extended.

CONCRETE BLOCKS.

A considerable proportion of the time of the convention was devoted to the consideration of various phases of concrete block construction for buildings. The report of the Committee on Tests of Cement and Cement Products included proposed forms of specifications governing the manufacture of such blocks (in which mechanical mixing was recommended) and recommending that persons intending to manufacture blocks should be required to take out licenses. A different set of specifications for the same purpose was included in the report of the Committee on Laws and Ordinances as noted above. Neither of these were adopted, but it was voted that the Executive Committee should appoint a special committee to prepare specifications and submit them to the members.

In the general discussion it was stated that there is a lack of knowledge of methods of measuring voids in sand and aggregate, and also lack of knowledge of the necessity of determining these voids in relation to the proportions of cement to be used. The chairman called for a show of hands from those present engaged in the manufacture of blocks, and this indicated a large representation, but when he inquired how many of these make a regular practice of measuring the voids in the local materials which they use, not a single hand was raised. This was regarded as fairly conclusive evidence that "rule of thumb" methods exist to a very great extent.

Mr. M. S. Daniels (Suffern, N. Y.), Chairman of the Committee, brought up the question of standard sizes for blocks and their relation to architects' plans. Mr. Daniels spoke of cases where stock sizes of lintels were used for small windows, projecting far beyond the openings, when they might easily have been cut to proper length. In other cases, small pieces of blocks were used, and mortar joints (both vertical and horizontal) 1 to 2 ins. thick were used to bring the blocks to fit the various openings. Naturally, an architect would not be impressed favorably by block construction when he saw work of this kind.

While standard sizes may be adopted, it should be remembered that most of the block machines will make blocks of various sizes, so that by conference between the architect and the block maker, there should be no difficulty in getting proper results, without unsightly cutting or patching.

Several members had had trouble in getting masons to lay the blocks properly. Care should be taken to have the mortar joints well filled, especially around the moldings and decorative parts at window and door openings.

Mr. Larned (Boston) spoke of the danger of using bank gravel, the proportions of stone and sand not being uniform, while the fall of the material as it is excavated from the face of the bank results in an automatic gravity separation of the different sizes. The desired uniformity can only be secured by gaging the material. In crusher-run stone, there is a similar separation if the material is handled by elevators or conveyors, and when the bin doors are opened the coarse stuff tends to run out first. The only way to get real crusher-run material is to take it direct as it comes from the crusher.

He also considered that blocks would be harder and more dense if cured in steam, but Mr. Humphrey (Philadelphia) pointed out that there are dangers attending this process. The changes of temperature due to the placing of a cold machine-made block directly in a steam chamber and then removing the hot block to the open air may be very injurious; beyond a certain temperature, also, the moisture in the block will be converted into steam, and the block will become porous and weak.

A very interesting discussion of concrete block manufacture was given by Mr. S. B. Newberry (Sandusky, O.). He explained that the steaming is simply for the purpose of accelerating the process of curing, but it is not yet certain that the crystallization which occurs in curing can properly be accelerated. The drying of the blocks in a room heated by steam radiators, as mentioned by one speaker, is not curing or steaming, and takes moisture from the block which is needed for crystallization. Very few block makers realize the difference between sand and gravel in relation to the strength of the block. They often use an inferior material, when a better is at hand. A 1 to 3 sand mixture will be actually strengthened by the addition of five parts gravel, making a 1 to 8 cement and gravel mixture. The pebbles of the gravel give the strength due to their own crushing strength and reduce the amount of cement required in the mortar without reducing the strength of the resultant concrete. He did not approve of the use of a facing mixture, especially a fine cement and sand facing; a roughened and variegated surface is far preferable. There is also much misunderstanding as to the amount of water required; applying water to the finished block does not have the effect of water in the mix. Even the dryest mixture has enough water for crystallization, but a wet mixture is denser as the water carries the particles into the voids. The concrete for blocks should be just plastic enough not to sag or fall when the sides of the mold are removed. The addition of a proportion of hydrate of lime makes the mixture dense and waterproof, but he has abandoned its use in favor of a waterproofing compound.

MACHINERY FOR CEMENT USERS.

A paper upon this subject was read by Mr. J. F. Angell (Columbus, O.), but referred almost exclusively to machinery for cement block makers. It is a mistaken idea to employ hand mixing, even for a small business. Even if carefully done, it cannot give as good or as uniform results as machine mixing, while the class of labor employed in hand work is generally in-

efficient. There are hand-operated machines suitable for very small plants.

WATERPROOFING CONCRETE.

This subject was taken up at the morning session on Jan. 11, five papers being submitted, dealing with various methods. Mr. Wiederhold (Philadelphia) dealt with the use of asphalt mastic applied to the face of the concrete, and described this method as applied to reservoir lining, subways and other engineering works. Mr. E. W. DeKnight (New York) pointed out that there are two general systems: 1, to make the concrete itself impervious, and, 2, to protect the concrete by some facing. He objected to the former system partly on the ground that cracks are always liable to occur in the concrete, which would admit moisture. He considered that mastic and the use of paper and burlap in connection with asphalt or pitch had not been successful, but advocated sheets of felt saturated and coated with bituminous cement, and forming a waterproof membrane. Mr. J. W. Fish (Sandusky, O.) presented the advantages of making the concrete itself waterproof by the addition of a certain compound to the mixture in the proportion of 1 to 2% of the weight of the cement used. Mr. G. F. Fry (Indianapolis) described still another method, intended more particularly for concrete blocks, in which the block (after having set to a certain extent) is given a wash or coating of a liquid preparation, which enters into the pores and on evaporating leaves a solid but elastic material behind. The last paper by Mr. S. T. Binswanger (Chicago) reviewed a number of processes and advocated the use of a cement paint of a special waterproofing wash of foreign invention.

In the discussion, the president, Mr. Humphrey, required speakers (most of whom represented various processes) to avoid reference to individual works or processes, and thus kept it entirely upon a technical basis. As to whether to waterproof the inner or outer face of concrete it was shown that the aim should be to keep the water from reaching the concrete; thus a concrete reservoir would have the lining on the inside, while the foundation of a building would have it upon the outside. Washes of any kind usually affect the color, and are often objectionable on this account as far as block buildings are concerned, while in many cases they have proved ineffective. Pitch or asphalt, on the other hand, are very likely to separate from the concrete and are also liable to crack. Two or three speakers suggested that the use of waterproofing compositions in the concrete mixture would by excluding moisture prevent the concrete from setting properly, but Mr. Humphrey explained that the concrete contains sufficient moisture in itself. It was further suggested that blocks having an impermeable surface could not be bonded properly with the mortar joints, but this appears to be a groundless objection. Mr. Marsh advocated a waterproof course (for buildings) extending up the outside of foundation, across the footing and under the floor, making an unbroken surface.

FIREPROOFING AND INSURANCE.

The report of this committee stated that during the past year there were no fires of importance in buildings of concrete-block construction, but that tests conducted by various parties tend to confirm the view that concrete properly made and applied is an excellent fire resistive material for certain uses, but has limitations which preclude its being classed as absolutely fireproof. Tests reported by Mr. Somerville, of the Washington Building Department, demonstrate that hollow blocks will break apart from unequal expansion of the different sides if exposed to a very serious fire. Such blocks are not suitable for fire walls or for any part of a building which may develop a fire of high temperature or long duration. Other experiments involving fire of shorter periods or lower temperature have not developed this weakness, and indicate that under conditions of comparatively mild exposure hollow blocks may be reasonably safe. Apart from the San Francisco fire there has been little actual demonstration of the fire resistance of reinforced concrete. That fire, however, furnished numerous examples of very good results in concrete floors.

BUSINESS MEETINGS.

The report of the Executive Board showed that the sum of $300 had been presented to the former secretary, Mr. C. C. Brown, in recognition of his services. The financial results of the year were approximately as follows: Balance on Jan. 1, 1906, $160; receipts, $2,400; expenditures, $1,500; balance on Dec. 31, 1906, $890. The membership is about 300, but active efforts are to be made to increase this. The selection of the place of meeting for the next convention was, by resolution, referred to the Executive Committee, with power to act. The election of officers resulted as follows: President, Richard L. Humphrey; Vice-Presidents, Merrill Watson, M. S. Daniels, O. U. Miracle and A. Monstead.

COST OF STEAM SHOVEL WORK BY RAILWAY FORCE AND BY CONTRACT.*

By John C. Sesser,† Assoc. M. Am. Soc. C. E.

Railways are doing or organizing to do their steam-shovel work with company forces and equipment, and are able to do this work from 25 to 30% cheaper than the price for which it could be done by contract. Among the various jobs of grade reduction work which were done on the Burlington System during the season of 1906, there were two on the Beardstown-Centralia Division, known as the Big Shoal cut-off and the Little Shoal cut-off, respectively.

BIG SHOAL CUT-OFF.

The Big Shoal cut-off was a change of alinement and grades between Sorento and Reno, Ill. On this cut-off there was 318,711 cu. yds. of earth to be moved, of which 251,711 cu. yds. were steam-shovel work. Bids were asked of the larger contractors of the country for this grading, and, while their prices per yard were reasonable, they were higher than that for which the company could do the work. Consequently it was decided that the company should do the work themselves, with their own forces and equipment. A record of the costs of this work will be of interest, as will also a comparison of the cost, to the company, for work done by its own forces with that for which the contractor would have done the same.

On this work two temporary trestles were built, having a total length of 2,961 ft. and an average height of 40 ft. The material for the embankment was hauled from the north, an average distance of 1½ miles. The average depth of cut was 15 ft. The material handled was clay. On account of numerous springs encountered, both material and steam-shovel pit were very wet, which delayed this work to some extent. At times the clay would leave the dipper in chunks as large as the dipper itself. This made the dumping of cars from the high trestle rather dangerous, and necessitated the locking of the cars to the trestle before they were dumped.

The temporary trestle built was designed to carry a loaded train of 5-yd. dump cars before being filled, and the engine in service only after the trestle had been filled. Each bent consisted of two soft-wood piles, bracing and cap. Second-hand material was used throughout, with the exception of the bracing. Two 8 x 16-in. stringers were used per 13-ft. span. The stringers were recovered, and the balance of the material was buried in the embankment.

The equipment consisted of a 65-ton Bucyrus steam shovel, two 30-ton switch engines, 43 dump cars (5 yds. capacity) and a Jordan spreader. The shovel worked 228 shifts of 10 hours (day and night), with an average output of 1,104 cu. yds. per shift, or 3.35 cu. yds. per car. The day shift comprised 70 men and the night shift 28 men. A summary of the details of cost is given at top of next column, and in each case the equipment includes the shovel, cars, engines, bunk horses and water supply.

The cost of this work could have been materially reduced had 12-yd. dump cars been used; the 5-yd. car is too light in construction for the service required in handling such heavy material as on this work. On account of complying with the enginemen's schedule, there was expended on this work $431, for which we received no service. This is about 10% of the cost of the supplies. The cost of this work to the company could have been reduced somewhat if we had not been handicapped in being governed by schedules, and also if we had had the same freedom in the handling of labor, supplies and commissary as does the general contractor.

*Abstract of a paper in Bulletin No. 81 (November) of the American Railway Engineering and Maintenance of Way Association, Chicago.

†Engineer of Construction; Chicago, Burlington & Quincy Ry.; Centralia, Ill.

	Big Shoal Cut Total	Per cu. yd.	Little Shoal Cut Total	Per cu. yd.
Equipment	$2,733	1.0 cts.	$2,911	1.5 cts.
Steam shovel (labor and supplies)	23,351	8.9 cts.	18,136	9.6 cts.
Temporary trestle	9,008	3.6 cts.	5,853	3.1 cts.
Track work	12,438	5.0 cts.	7,817	4.2 cts.
Engineering and superv.	610	0.2 cts.	487	0.3 cts.
Total	$47,140	18.7 cts.	$35,205	18.7 cts.
Total by contract, at 26 cts. per yd.	$65,445	26.0 cts.	$48,942	26.0 cts.
Saving by company work	18,305	7.3 cts.	13,737	7.3 cts.

LITTLE SHOAL CUT-OFF.

The Little Shoal cut-off was a change of alinement and grades between Ayers and Durley, Ill. On this work there were handled 188,240 cu. yds. of material. A temporary trestle was built, having a total length of 2,14[illegible] ft., and an average height of 35 ft. Material for the embankment was hauled an average distance of half a mile. The material handled was about 40% hardpan, it being about as hard a material as the shovel could dig without resorting to blasting. On this work both shovel and engines were handled over 6% grades and 16° curves very easily. The cost of this work to the company is given in the accompanying table.

Had this work been let to a contractor, it would have been necessary to make some allowance on account of hard material, which would make the saving considerably more. Also, there is the factor of free transportation and freight, which would also be given them. This cost includes all items of freight, supplies, labor and any others that are possible to include that should be charged to this work. It has been the intention in estimating this to get as close an estimate of actual cost to the company as possible.

SUMMARY.

From the results obtained from a number of trestles of the kind above described that the writer has had to build, the following conclusions have been reached:

1. For trestles from 20 to 60 ft. in height, the cost per yard of embankment for temporary trestle should be approximately the same for all heights between these limits.

2. Except as an approach to higher trestle, it is not economy to build trestles under 16 ft. in height.

3. On all trestle work over 30 ft. in height a scab should be placed on cap and pile to prevent cap turning. It seems to be the better practice to place the scab on the side toward the filling.

4. On all trestles over 30 ft. in height longitudinal bracing should be placed on the side of the pile toward center of trestle.

5. When necessary to use jack braces, they should be built toward the bank that is being filled, so as to put the members in tension rather than compression.

6. Sway braces should be placed on the side of the bent toward which the material is being dumped.

7. If possible to avoid it, soft ties should not be used on high trestles.

The limits to which a shovel will work is a most important consideration in planning and estimating work of this kind. It is not economy to work the shovel to its extreme limits in lift and reach. The shovel used on this work, at times, loaded the 5-yd. cars on a loading track which was 9 ft. 2 ins. higher than the shovel track, with the tracks 22 ft. c. to c. Loading at such height is very slow work and is liable to wreck the cars badly on account of the lack of clearance for the return of the dipper after emptying.

When there is more than one cut to be made and where time is the all-important factor, 7 ft. difference in elevation between the shovel and loading tracks allows rapid work and gives better results.

In laying out steam-shovel work considerable saving can be effected at times by taking advantage of the natural conditions of the work as they exist. The track arrangement and the future track arrangements as the work progresses is a thing that is oftentimes neglected and causes serious delays to the shovel. On very few jobs has the writer seen the shovels work to their capacity on account of poor track arrangement and the consequent inability to keep cars supplied to the shovel. One must have good running track over the entire work. With good track and proper arrangement, ideal conditions for a maximum shovel output are obtained.

The reports above show the cost to the railway company of this steam-shovel work. In these reports the cost of each kind of work in connection with the steam shovel grading is given. Where equipment of this kind is used, it is taken as a fair average. Comparing these two reports as to final cost, it is interesting to note that the cost per yard in place on either job is precisely the same. While the equipment and organization were, in a way, about the same at both places, the material handled and the general layout of the work were very different.

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The message of President Roosevelt to Congress asking authorization and appropriations for the work of closing the crevasse in the banks of the Colorado River ought to meet an immediate and satisfactory response. We can conceive of no possible reason why there should be an instant's hesitation to grant the Executive all necessary authority and means in a case of such urgency. If war were threatened, a President's request to Congress for funds would be acted on without delay of a single day. The loss and destruction to property values threatened by the Colorado River in its present course are only to be compared to those which would be wrought by war. It is true that the bulk of the property values which the river threatens to destroy are in the future rather than the present; but action for their preservation is no less imperative.

The President's message makes clear, too, that for the immediate action which is so urgently demanded, the only organization that can possibly move in time is the Southern Pacific Co. The force of men, teams and rolling stock which succeeded in closing the break in November is still at work, straining every muscle and nerve to again dam the rushing torrent; and although flood after flood has swept down the river and overwhelmed portions of the works, the battle is still being waged.

As was stated in our issue of Jan. 3 and again by President Roosevelt in his present message, a deep canyon is being cut by the current in its passage down the Imperial Valley to Salton Sea, and this canyon is steadily and rapidly working back upstream. It can hardly be six months at longest before it will reach the old bed of the Colorado where the closure is now being attempted, and when that occurs we see no possible way of turning the Colorado back into the Gulf. Further than this, there is probably not even six months available for the closure work. In early June the regular summer floods of the Colorado may be looked for and the break must be closed before that time, and closed by barriers so strong and impermeable that the June floods can neither overtop nor undermine them.

While the actual fight with the river must be waged by the Southern Pacific organization and forces, these men ought to have the aid and counsel of the ablest engineers in the Government service. It is true that the task is almost without precedent and that even the best hydraulic engineer would find it difficult to say certainly what plan had best be adopted for closing the break in the limited time available. Nevertheless the railway managers who are making the desperate fight ought to be able to ask at any time the advice of men experienced in hydraulic work, and the gravity of the situation demands that three or four of the ablest engineers in the Government service be sent at once to the site of the closure works to render such aid as they may toward their success.

For weeks and probably months to come, until the issue is finally decided, the attention of the engineering profession will be concentrated on this strenuous battle to dam a torrential river in the shifting silt of its delta. Whatever the result of the battle may be, the lesson will be well taught that private interests cannot safely be permitted to experiment with our water courses without some measure of Government supervision. The construction and maintenance of dams and reservoirs and irrigation systems by private enterprise ought to be subject to some sort of supervision and control by either State or National authority. The Salton Sea diversion of the Colorado is an extreme illustration of the vast property damage which irresponsible and incompetent meddlers may cause; but we need only refer to the Johnstown flood and the Mill River disaster to show that there have been other object lessons to teach the same thing.

The use of copper sulphate for the prevention of trouble with algae growths in public water supplies began to attract attention abroad directly after the appearance of the bulletin by Moore and Kellerman, issued by the U. S. Department of Agriculture in 1904. The reception of the idea in England has been remarkable, in view of the conservatism that prevails there. Of course there are still plenty of Englishmen who view with horror the idea of putting a "poison" or a chemical into a public water supply; otherwise mechanical filtration would doubtless now be more extensively used in England. The use of copper sulphate in connection with slow sand filters was the subject of a paper by Dr. Adolph Kemna of Antwerp, Belgium, read before the British Association of Water-Works Engineers, in December, 1906. The paper is printed nearly in full elsewhere in this issue, and to it we have appended a brief abstract of the lengthy discussion of copper sulphate for algae treatment in general, which the paper brought forth. Dr. Kemna, as many of our readers know, is one of the leading water biologists and experts of Europe.

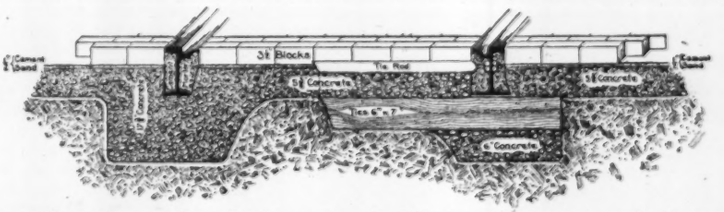
The paper and discussion might well be read in connection with the notable report on stripping reservoir sites (by Messrs. Hazen and Fuller), which appeared in our issue of Jan. 3, 1907. Of course it would not be fair to make direct comparisons between the ideas expressed in the report just named and in the paper and discussion which we now place before our readers, since the viewpoints are, in many respects, so different. It may be noted, however, that Dr. Kemna uses some strong general language to the effect that the only way to be rid of algae is to kill them, and that they can be killed only by using poison, while Messrs. Hazen and Fuller are confident that a combination of aeration and filtration will dispose of the algae, or at least of their evil effects.

But it is on the surface of slow sand filters that algae have given trouble to Dr. Kemna, and also to one or more of the British engineers who discussed his paper. This particular problem, however, is quite different from the growth of algae in large impounding reservoirs, which was being discussed by Messrs. Hazen and Fuller. At both the Antwerp and the York water-works the water is drawn direct from rivers, instead of being impounded. While the discussion of Dr. Kemna's paper confirms the general statements of Messrs. Hazen and Fuller, as to the few algae in British reservoirs, as compared with American, it seems to indicate that the British have more trouble with algae than Americans have supposed. Inasmuch as surface waters are generally filtered in Great Britain, it would seem relatively easy, in many cases, to secure immunity from algae by introducing aeration before filtration, as proposed by Messrs. Hazen and Fuller, for the additional water supply for New York City.

Is it good engineering to bury wood in concrete? What will the life of wood be under such conditions? This question is coming up for consideration very frequently nowadays and we should be glad to hear some authoritative expressions of opinion, or, better yet, some results of actual experience.

The subject is brought to our attention just now by the accompanying cut,* which appears in the "Journal of the Association of Engineering Societies" for November, and shows a section of the electric railway tracks on Washington St., Boston. Similar track construction has been adopted in many other cities, and has now been in service long enough, we judge, for its weak points—if it has any—to become apparent.

To support a street railway track on elastic and perishable wooden ties, and fill in around and over them with solid concrete has always appeared to us to be an objectionable construction. Possibly it may be considered that the tie only serves as a temporary support and that eventually as the concrete hardens the rail is actually carried by the concrete between the ties. If this is true, however, it ought to be feasible to use something much cheaper in original construction than the first-class ties that are generally demanded for street railway construction.



But our object in writing this note is not to push forward our own opinions, but to call for records of experience. Can we bury wood in concrete above water level and not run great risk of dry rot? What has happened to street railway ties which have been buried in concrete during the past half-dozen years or more? We shall be glad to hear from our readers.

A notable event in the annals of American engineering societies is to be recorded for the week just past. The first public meeting was held in the great United Engineering Society building in New York City, the building which is to be the home and headquarters of nearly all the principal

*The following description, by Mr. Arthur L. Plimpton, of the construction shown appears in the "Journal":

"You will note that the rails are supported on the usual tie construction, ties being 2.5 ft. on centers, which in turn are supported in and on a continuous concrete beam extending 6 ins. below the bottom of the ties, and about 5.5 ins. above them, giving a total thickness of about 17.5 ins. These beams are connected by an arch of concrete, which gives about 5.5 ins. of concrete base in the middle for the wooden block pavement.

"Previous experience on Beacon St., where wooden blocks were laid in 1901, showed the importance of doing the work in such manner as to prevent water from working down at the side of the rail, which, when followed by freezing weather, will cause the blocks to heave up. In laying the tracks on Washington St., therefore, it was decided to plaster with cement mortar next the rail its entire height just before putting in the concrete, which insured intimate contact between the concrete and the rail; so that when done there were no voids left in which water could accumulate. In the work recently done of relaying the tracks on Beacon St. with wooden block pavement the blocks themselves were laid on a layer of cement mortar and the joints filled with cement grout.

"Cars were not run on the tracks on either Washington or Beacon St. until the concrete had been in place for ten days.

"The whole aim in this form of track construction is to eliminate all movement of the rail under passing cars as far as possible."

national engineering societies. From now on, the use of the house will be continuous. Several other meetings will be held there during the present month, and by the time the formal opening ceremonies take place in April, the building will be fully established in its permanent function as a center of engineering interest and activity.

SOME LESSONS OF THE CAR FAMINE.

Probably at no time in the history of American railways has there been so much and so serious complaint against railway companies for failure to furnish transportation as during the past four months.

The public discussion of the railway rate question a year ago made it clear that slight variations in rates charged for freight enable the railway companies to make one concern rich and drive another out of business, to make one city prosperous and another decadent, to foster the growth of one industry and starve the life out of another.

In these days, however, the further fact is being forced home by daily object lessons that in our modern social fabric transportation is as absolute a necessity of life as food or shelter. Every large city is dependent for its food supply on the railway lines radiating from it. Stoppage of traffic on these would mean an immediate famine in perishable articles; and in a very few days scarcity would be felt in all the great staples of consumption.

In the climate of the northern United States fuel for domestic use is as necessary as food itself. That means that in order that life shall be sustained and people be kept from freezing to death in the winter months, the railways must carry coal from mines distant perhaps a thousand miles and lay it down within reach of the consumer. We say MUST, and it is well that the must should be emphasized. The legal duties of a common carrier are not only to treat all parties alike, but to actually furnish the accommodation which the public requires. If people are starving to death or freezing to death because the railways did not haul the food or the coal to save them, it is no sufficient excuse on the part of the railways that their equipment was busy elsewhere. The railway has revolutionized our whole social and industrial organization. It has created communities and cities and states, and has made itself a necessary servant of the public. It cannot evade the responsibility of furnishing this necessary service.

And yet, with this responsibility freely admitted by the railway managers, there come to us from the Northwest reports of a multitude of cases where the railways have failed to furnish transportation and whole communities are suffering in consequence. Over large districts a coal famine appears to exist. Case after case is reported where, under the stern compulsion of the necessity that knows no law, the inhabitants of towns where the stock of fuel was exhausted have stopped through freight trains and dumped the cars loaded with coal in order to obtain a fuel supply. In many other towns located on branch lines no such relief has been possible, and their people have had to burn valuable lumber, fences and even buildings to save themselves from freezing.

Again, the railways have failed to furnish the transportation demanded to move the grain crop of the Northwest. The present situation is tersely summed up by Hon. Franklin K. Lane, of the Interstate Commerce Commission, in a report to President Roosevelt on Jan. 2. We quote from it as follows:

> The railroads tapping the great grain belt of the Northwest seem to have been overwhelmed by this year's crop, although in fact, the crop scarcely exceeded that of the year 1905 in volume, nor did it equal that of at least one other preceding year.
>
> Fifty million bushels of grain, as nearly as can be estimated, remain on the farms or in the country elevators of North Dakota. But 38% of the crop has been shipped. The country or line elevators at a large number of country stations are full. Some of these reached their capacity as early as September, and still contain the grain they then held. Thousands of bushels of wheat are lying at this time covered with snow in open bins built beside the railroad track. The farmer cannot sell because the country dealer cannot buy. The country dealer cannot buy because the country elevator is already full. The country elevator remains full because the railroad has not moved the grain from the country elevator to the terminal elevator. The terminal elevators at Duluth, Superior and Minneapolis which act as great reservoirs for the line elevators are almost empty, and at no time during the season have they been filled to more than one-third of their capacity.
>
> This unfortunate chain of conditions has involved financial loss to a not inconsiderable percentage of the population of the Northwest. It is a loss which begins with the farmer but includes the merchant, grain dealer, the elevator man, the miller and the railroad. And such loss is to be reckoned in figures computed on a basis of the reduced price upon millions of bushels of grain—for every bushel of which there is a demand. The farmer has been compelled to ask the merchant to extend his credit. The merchant, the elevator man and the country dealer have been forced to secure new and unusual loans at the banks. The dealer who sold grain for November delivery has failed to keep his contract and "made a loss." Interest and insurance have eaten away the profit of the dealers, and the price of grain has fallen from two to six cents per bushel at a large number of country points.
>
> The situation last year, while not satisfactory to the shippers, did not present the distressing features that developed in 1906. Yet in the year 1906 both the Great Northern and the Northern Pacific largely increased their equipment. Notwithstanding this increased equipment they hauled less grain, they furnished fewer cars to the line elevators and delivered fewer at the terminals.

The situation in North Dakota is unfortunately not the only case where the railways are convicted of failure to furnish transportation for the crops. Mr. Lane's report showed that from over a hundred towns in Iowa came complaints of inability to secure cars for grain shipment. The estimates of loss from these causes made by grain dealers run from $500 to $5,000 each. The demand for cars was such that minor railway officials have been obtaining graft from shippers for favors in the assignment of cars.

A complaint of longer standing comes from the fruit-growing sections of the South, where crops of strawberries, peaches and other fruits have rotted in the fields because the growers could obtain no cars for shipment. We may also cite in this connection the testimony taken some months ago in the investigation of Pennsylvania Railroad affairs, where it was shown that favored coal companies in which officials of the railway company were interested were able to secure all the cars they wanted for shipments, and the cars, when loaded, were promptly forwarded to destination, while competing coal companies had all sorts of difficulties in obtaining cars and in securing their movement to destination when loaded.

It needs but the recital of these facts to show the urgent need that something be done to remedy the situation. It is no sufficient answer to say that prosperity is giving the railways more business than they can handle, or to say, as President Hill, of the Great Northern, has done, that the railway systems of the country ought to be duplicated. The people who are suffering grievous losses through such failures on the part of railway companies to observe their obligations are in no mood to accept excuses.

President Ripley, of the Santa Fe, is quoted in Topeka dispatches of Jan. 11 to the effect that the best remedy he can suggest is to let the railways alone; but such a remark betrays singular blindness to the fact that the public demand for railway legislation grows out of these failures by the railway companies to live up to their obligations. There has been no legislation or threat of legislation that has prevented the railway companies from operating their roads in an efficient manner, nor from obtaining all necessary capital to increase their facilities. Difficulties in financing the needs of railway companies have been due to distrust by investors of the Wall Street system of railway control and operation, rather than to any fear of public interference with railway revenues.

The cause of the car shortage which has wrought such wide damage of late is of a deeper root than mere lack in number of cars, or in a coincidence of heavy crops and business prosperity. In fact, not one cause, but many, have contributed to create the present condition. [illegible] ably the least important factor is the num[illegible] cars owned by the railways as a whole. [illegible] total number of freight cars in service [illegible] was 1,196,119. In 1905 this had increas[illegible] 1,731,409. Coincident with the increase in [illegible] ber of cars there was an increase in a[illegible] capacity. In 1904 the average capacity [illegible] freight cars in service was 30 tons. It is [illegible] able that this was an increase of at least [illegible] or eight tons over the average capacity [illegible] freight cars in service ten years earlier. It seems well established, therefore, that [illegible] car capacity has increased as fast as the t[illegible]

If we take specific cases, the same thi[illegible] shown. Commissioner Lane found that the [illegible] Northern and Northern Pacific have much [illegible] equipment now than they had in 1905, [illegible] they moved larger crops from Dakota [illegible] Minnesota with much less complaint of car [illegible] age. Nor were their cars diverted to other [illegible] for the balance of car equipment at the dat[illegible] investigation was made was in favor of the Great Northern to the extent of 2,000 cars, and in favor of the Northern Pacific to the extent of 6,000 cars.

The most direct cause of the coal scarcity in North Dakota he finds to be congestion of the terminals at Duluth and Superior; but the question which immediately comes is why provision for enlarging these terminals was not made before the congestion occurred. Certainly both these companies have been for years in financial condition to obtain capital for all reasonable expansion.

Again, President Ripley, of the Santa Fe, argues that car shortage is due to a plethora of traffic during four months of the year, and claims that the railways cannot be expected to supply equipment for these busy months, much of which will remain idle during the eight remaining months.

That traffic in any given section will not be uniform throughout the year is, of course, evident; but the railways have it in their power to do much to equalize the demands upon them. President Ripley complains that dealers do not purchase and ship coal needed for the winter's consumption until just at the time when the railway rolling stock is taxed to move the fall crops. If he desires to move coal in the summer, however, concessions in rates will secure its movement at that time instead of in the winter months. While stability in rates is conceded by all to be desirable, a variation in rates which would tend to equalize traffic movement throughout the year would be a benefit to the public and to the railways as well.

Again, the present system of car interchange between different railways and of control over car movements needs radical overhauling to adapt it to present-day conditions. There are serious difficulties, admittedly, in the pooling of freight car equipment by all the railway companies of the country; yet such a system promises to solve so many of the present troubles that it must in some way be brought about. It would probably be in operation to-day if the controlling men in the railway world were as competent to handle great questions of practical railway management as they are to manipulate the stock market.

Probably as much or more can be done for the betterment of railway service by accelerating the movement of cars when loaded as by hastening the loading and unloading of cars by shippers. Figures submitted to the Interstate Commerce Commission by the largest receivers of grain in Chicago showed that the average length of time required for switching loaded cars to the elevator after notice of destination is received by the railroad is from 3½ to 5 days, and for carload freight to be switched through Chicago takes from 8 to 15 days.

From many quarters come complaints that the desire to save in operating expenses and make a great showing to stockholders by hauling heavy trainloads has been overdone. Locomotives have been overloaded; stalled trains have delayed traffic and caused loss instead of gain; the consequent delays to shipments have been, accord-

ing to Commissioner Lane, no small factor in the car shortage situation in the Northwest.

Space does not permit a more detailed review of the situation, but it may be pointed out that the Interstate Commerce Commission does not ask for legislation on the subject or recommend any panacea. What the condition demands is greater ability on the part of railway managers to deal with the problems presented to them, and the support of competent railway managers by the men who represent railway ownership to enable needed reforms to be put in force. Commissioner Lane well sums up the situation as follows:

"Throughout this inquiry the thought has repeatedly suggested itself that many of the problems presented must rest for their solution in the character and intelligence of the railroad managers—their foresight, initiative, adaptability and public spirit. Whatever of criticism, there is to be expressed should in justice be tempered by a consciousness of the novel and perhaps unparalleled difficulties which the problem of American railroad transportation to-day presents.

"This demand, however, the shipping and producing public is certainly justified in making—that every railroad shall do its utmost, not alone and of itself but by community of action with other roads, to render the service which is imperatively needed, and shall act in supreme good faith in endeavoring to organize and equip itself for such service. Methods which were sufficient to fully meet the needs of the largely localized traffic of a few years since are at this time properly subject to re-examination. Policies which hitherto have suffered should now be reconsidered with respect to the requirements of new conditions and much broader considerations.

LETTERS TO THE EDITOR.

Settlement of a Foundation on Silt and Alluvium.

Sir: The figures given in Engineering News of Dec. 20, 1906, for "Allowable Pressures on Deep Foundations," from a paper by Mr. E. L. Corthell, proved very interesting to me. In silt and alluvium, two cases of settlement are given. I beg to add one for a shallow foundation, from the recent construction of a small permanent wharf.

The understructure of timber cribwork, 90 × 30 × 6.3 ft. average height, bottom sloping about 1 in 4, settled 0.5 ft. with mean pressure on bottom 225 lbs. per sq. ft. in excess of displaced water. The superstructure 17 ft. high of concrete cribwork, with 6 ft. of earth filling, floor slabs, etc., added a distributed load of 1,200 lbs. per sq. ft. and increased the sinkage to 2.1 ft.

The elasticity of concrete cribwork construction made it easy to control the sinkage in order to keep the courses nearly level.

Yours truly,

R. de B. Corriveau.

Department of Public Works, Canada, Ottawa, Jan. 2, 1907.

Vertical Curves.

Sir: Replying to the request of H. G. Ewling in his letter in your issue of Nov. 22, 1906, I forward a blueprint of the method used in our office for the computation of vertical curves. As noted on the accompanying statement, by taking the proper value of g for substation the ordinate at any desired point may be readily computed.

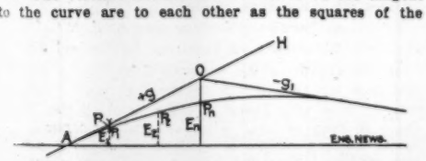
Yours truly,

W. C. Whitney.

Boston & Albany R. R., Boston, Mass., Dec. 17, 1906.

Given grades g and g_1, and the number of stations n on each side of O, the center of the curve. Let P_1, P_2, P_3, P_n be stations on the curve.

1. The vertical distances from stations on the tangent to the curve are to each other as the squares of the



number of stations from A (P, 4P, 9P, 16P, etc.; $OP_3 = n^2P$).

2. The offset from the tangent to the first station is

$$P = \frac{g - g_1}{4n}$$

3. Referring the points on the curve to the horizontal line through A, the offsets E_1, E_2, E_3, which added to Elevation of A give Elevations at stations P_1, P_2, P_3, are shown in the first column below; the differences in elevations between successive stations are shown in the second column.

Offset.	Differences in Elevations.
$E_1 = g - P$	At $E_1 = g - P$
$E_2 = 2g - 4P$	At $E_2 = g - 3P$
$E_3 = 3g - 9P$	At $E_3 = g - 5P$
$E_4 = 4g - 16P$	At $E_4 = g - 7P$
$E_5 = 5g - 25P$	At $E_5 = g - 9P$
$E_6 = 6g - 36P$	At $E_6 = g - 11P$

Close attention being paid to the algebraic signs of g and g_1, these formulas apply to all cases of convex and concave curves.

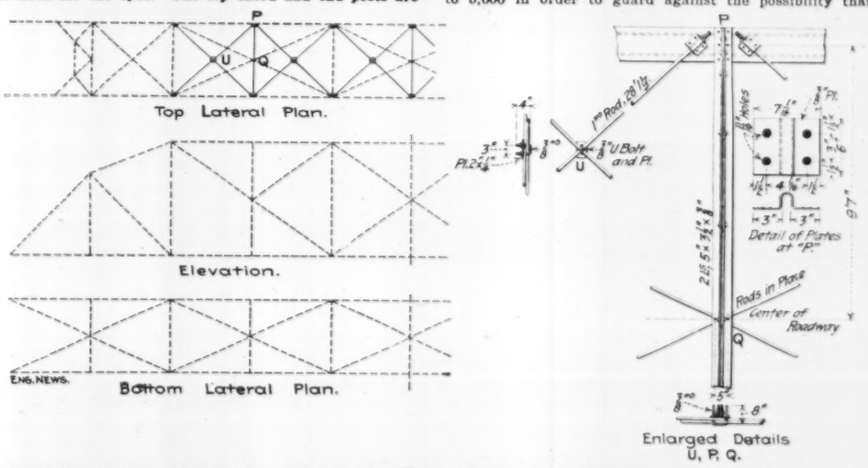
4. The level being set up at A, the elevations of P_1, P_2, P_3, etc., may now be established.

5. The same formulas apply in setting substations. Thus, if g for 100 ft. is 0.8, for 25-ft. substations g = 0.2.

6. Where practicable, the curve should be 200 ft. long for each 0.1 change in rate of grade on lines where the average change is about 0.5; or 100 ft. long for each 0.1 change where the average change is about 1.0.

Two Highway Bridges of Flimsy Construction.

Sir: I hand you herewith blue print showing temporary reinforcement of a 208-ft. pin-connected span over the Red Lake River at Thief River Falls, Minn., which the writer was called upon to investigate. The diagram of the present bridge is shown in the dotted lines. The center bottom chords—two bars 4 by 1⅛ ins.—are of wrought iron with turned loops, butt-welded in the neck for the eyes. The top chord and end posts are



PIN-CONNECTED HIGHWAY BRIDGE OF 208-FT. SPAN, AND ADDITIONAL TOP LATERAL SYSTEM.

two 10-in. channels and a 14 by ¼-in. plate, and the vertical posts two 5-in. channels, laced.

Referring to the diagram, it will be seen that there are three double panels in the central portion of the bridge in which the top and bottom laterals connect only at the main panel points with the main posts; in other words, the top chord section is laterally unsupported for a length of 41 ft. 6 ins. It is supported in the center vertically, and spliced over the vertical sub-post, this splice consisting of a cover plate ¼-in. thick and 5 ins. long. A little patch plate is placed on the bottom of the channels 2¼ by ¼-in. and 5 ins. long, with one rivet at each end. The lateral rods in these three top panels are about 45 ft. long and the way they jog up and down when a team goes over the structure is a caution. With a pair of horses trotting over the structure, the vertical vibration is perhaps in the neighborhood of an inch or an inch and a half. The bridge has stood up under fairly heavy traffic for fifteen years. Its live load capacity, assuming that the blacksmith work on the bars is first-class, would seemingly be about 15 lbs. per sq. ft., except that the top chords, with their splice in the center of their length, without lateral support, are perhaps in a dangerous condition even under such a load. The structure has a name plate, "Built by the Wrought Iron Bridge Co., 1901."

About four years ago the writer ran across another interesting highway "cob-web" in Wisconsin, in the shape of a 225-ft. draw-span of the combination order. The bottom chord was made of two planks braced together; the top chord and the end post at the end of the arm consisted of one angle 5 by 5 by ⅝-in.; the lateral struts of gas pipe, probably 2½ ins. and the lateral rods were ½ and ⅝-in., with a connection consisting of a hole cut through one leg of the angle and a bevelled washer for the nut. This interesting structure had been in use about twenty years—certainly a remarkable example of the toughness of the material and an indication of what a small percentage of the total live load we usually figure on a structure of that kind could have ever been placed upon this particular bridge.

Very truly yours, C. A. P. Turner.

Minneapolis, Minn., Dec. 10, 1906.

Unit Stresses in Concrete and Upon Editors.

Sir: In submitting this criticism, the writer would say that he considers the standing of Engineering News as perhaps the highest of any engineering paper in the country, due to the fact that its editorials have been, in the past, of the highest grade of value to the subscribers—professional and layman—in pointing out defective elements of design, both in railroad and bridge construction. The editors have been, almost invariably, conservative in endorsing opinions, and it is with no little regret that the writer has observed their failure to follow their well established custom in regard to reinforced concrete.

Referring now to the editorial on a recent concrete failure, your editor goes into a general condemnation of a type of construction that, properly designed, is the most economical, the safest and most permanent in use to-day, without attempting to analyze the design in question, or point out the character of the connections. In the case of failure of a steel building, this would generally be done, since experience shows failures in frame structures are usually in the joints. What remedy should be prescribed for such failures—better details, or a general reduction of working stresses to cover all manner of ignorance and lack of judgment in design and execution? What would the steel men say to the suggestion that the working stress in a steel structure should be reduced from 15,000 lbs. per sq. in. in bending to 5,000 in order to guard against the possibility that some ignoramus might forget to make a suitable joint, as a conclusion warranted by a failure in which loss of life occurred through such omission? However absurd such a suggestion might be, it is lacking in the dangerous possibilities of the editor's thoughtless advice to limit the working stress on concrete to 300 lbs. per sq. in. in shear or compression, without suitably specifying a given degree of reinforcement. [The editor gave no such advice, thoughtlessly or otherwise. In a note appended to a letter in our issue of Dec. 13, p. 623, we quoted Mr. W. J. Douglas' recommendation of 300 lbs. for compression in 1.2:5 concrete, in order to contrast the opinion of one experienced concrete man with the practice of another.—Ed.] It should be borne in mind that such thoughtlessness, however innocent on the part of the designer, may result in loss of life and criminal liability therefor, if the case in question is investigated by a coroner's jury capable of sifting the evidence of the collapse.

The editor's apparent idea that he has covered the ground in his specified working stress reminds the writer of the method of figuring employed by a certain manufacturer of steel hangers with a hooked end. He figured the reaction of the beam, the section in tension and the section in shear at the hook correctly, but forgot all about the bending, and five stories came down under less than the working load. Thus in figuring the shear on concrete in beams supported by columns, if there is not ample reinforcement to take care of the shrinkage strain within the period of the first six months, this 300 lbs. per sq. in. is fully ten times as high as it should be for safety to include these stresses, while, as a rational working stress, it is low to an equal extent where suitably and properly designed reinforcement is used for compressive stresses. For example, with a suitable mixture, and proper reinforcement normal to the stress, the writer has had occasion to place 1,800 to 2,000 lbs. per sq. in. on concrete seven days old, put in hot at a temperature 10° below zero and kept covered, while at the same time he is too conservative to figure even 20 lbs. per sq. in. on the same mixture in shear in a beam subject to shrinkage stresses, without suitable ties to take care of the latter.

If the editor will refer to the French rules for proportioning reinforced concrete, he will find that three-fifths of the ultimate compressive value of the concrete in cubes is allowable with a suitably designed lateral reinforcement. This would give a value of 3,000 lbs. per sq. in. in compression as an ultimate with a fairly rich mixture. Such value, however, would require a degree of lateral reinforcement not warranted from the economic standpoint in most cases. On the other hand there are many cases in which the writer would consider the editor's 300 lbs. per sq. in. as too high in view of the character of reinforcement very commonly used by those who do not consistently take into consideration the chances of the workman properly casting the columns. For example, a column, the shaft of which is cut through and through repeatedly by cross wires and ties, may prove a fairly efficient compression member if the concrete is poured in a sufficiently fluid condition. A single stiff batch poured in this column would be likely to catch on the ties and result in a spongy, porous, and dangerously weak section. We find nothing in building ordinances which pays any attention whatever to the character of the details used or proposed by the designing engineer, for the reason that, as a rule, the men who have framed these ordinances are almost totally ignorant of any scientific information regarding reinforced concrete, and hence frame laws which frequently tend to encourage rather than discourage the adoption of inferior or dangerous types of construction.

Where there is such an extreme range of permissible values in the use of reinforced concrete, the writer who possesses the temerity to suggest that a uniform value may be assigned for he working stress without taking into consideration the type of reinforcement used is indeed a dangerous authority for the contractor to follow in assuming the financial responsibility for the work, for, as above pointed out, his uniform low working stresses are quite as likely to be dangerously high to an extreme degree as they are, on the other hand, extravagantly low in other cases.

By inference it would seem that the editor is placing too much blame on the contractor for the large amount of unsatisfactory work that the honest advocate of reinforced concrete will readily admit is being done. The conditions may be more intelligently explained as follows: We have, for example, a number of concerns manufacturing, advertising and selling metal reinforcement of a fancy type. These gentlemen are coming into competition with plain bar reinforcement, costing but two-thirds or half as much per pound as their fancy material (and worth more, pound for pound, in some cases, as far as strength is concerned, when intelligently placed); hence, in order to make a profit, they are compelled to attempt to make one square inch of metal do the work that should be entrusted to two. They sell their metal and their design to the contractor who accepts their "hot air" assurance that the design is conservative and the reinforcement "the best in existence." Then he finds himself up against the proposition of making good the questionable or inferior work that he has been led into executing, in many cases by the representations of these parties and their semblance of business standing and responsibility as indicated by their advertisements in the various engineering and concrete journals. Should the contractor be blamed if, under such circumstances, he was uncharitably inclined to compare the engineering journals, as represented by the critical editor, to the yellow newspaper in this respect: they advertise any proposition for which they are paid, as the yellow journal advertises poisonous patent medicines with the pious feeling that it trusts the Lord will be with the party who swallows the dose, but does not desire, for evident business reasons, to express its opinion openly.

Yours very truly,

C. A. P. Turner.

Minneapolis, Minn., Dec. 27, 1906.

[We give space to the above letter because it is possible some other readers may have misunderstood our editorial position as extensively as the writer of the above appears to have done. We have at no time condemned reinforced concrete, as might be inferred from the second paragraph of the above letter. We have merely taken the ground that reinforced concrete construction ought to be in the hands of competent engineers, and if in this we have departed from conservatism, so be it.

The editorial in our issue of Nov. 29, to which our correspondent doubtless refers in his second paragraph, was not as he assumes "on a recent concrete failure," but referred to numerous failures which have occurred during the past two years.

It must not be thought that the publication of an article in our columns necessarily implies editorial approval of all of its contents. It is our aim to present the best of current engineering practice and to give opportunity for fair and intelligent discussion of matters on which opinions differ, whether we agree with the practice and opinions or not. By way of illustration, in describing a reinforced concrete building recently, we duly set down the fact, reported to us by the engineer, that the forms were removed from a 50-ft. concrete girder two days after it was poured. It did not follow, necessarily, that the editor approved of such work, any more than it follows that in publishing Mr. Turner's letter we approve the application of a 2,000 lbs. per sq. in. working stress on ten-day old concrete.

Lastly, as to the criticism in the concluding paragraph: We are far from being willing to concede that all forms of reinforcement for concrete other than plain bars are based on nothing but fancy. Certainly our correspondent, who is himself sponsor for a particular kind of reinforcement, will concede that reinforcing steel should be provided to care for shear as well as tensile stresses, and probably for bulging effects due to compression as well. And with this conceded it may as well be admitted that economical methods of assembling the reinforcing members and holding them securely in place while the concrete is poured around them may have some merit.

This being the case, we would have no moral or legal right to exclude systems of concrete reinforcement from our advertising columns. Further, not only would it be an impossible impertinence for us to attempt to pick and choose between different systems—allow one to advertise as meritorious and exclude another as defective;—but we would have, strictly speaking, no legal right to do so. Any firm conducting a legitimate business in the engineering line and financially responsible has a right to a place in our advertising pages provided its competitors in the same line are admitted.—Ed.]

Concrete Construction: "Restrained" Concrete and Full vs. General Specifications.

Sir: In your issue of December 20, 1906, under "Practical Hints for Concrete Constructors," p. 643, Mr. W. J. Douglas says: "Don't stress your concrete in compression higher than 300 lbs. per sq. in. (1:2:3 mixture) in beams, columns or arch work, unless you are going to have first-class inspection; 400 lbs. per sq. in. is high enough when the work is going to receive the best class of inspection." This having received your editorial approval, the writer wishes to say that this statement should be confined to ordinary concrete construction.

If concrete is restrained from flowing in all directions, there is probably no limit to the load it is capable of taking, provided the restraining influence is sufficient to overcome the tendency of the molecules to separate. The writer has been making tests on full-size columns and floor slabs built on the lines of restrained concrete, a new form of construction, which confirms this theory. For example, he has tests to show that concrete columns 6 ins. in diameter, 14 ft. long (90 days old), built on the above lines, have carried 7720 lbs. per sq. in. on the concrete, when the elastic limit of the steel was reached. If more steel had been used the load could have been higher. When these tests are completed the results may change some of our ideas as to how concrete should be utilized to the best advantage. The same may be also true of the use of steel.

Yours truly, J. W. Schaub.

Monadnock Block, Chicago, Ill., Dec. 21, 1906.

Sir: I have read with much interest the article in your issue of Dec. 20, 1906, by Mr. W. J. Douglas on "Practical Hints for Concrete Constructors." It is information such as this article contains that is needed on the part of concrete users in order to redeem this most excellent construction from the condemnation that blunderers are bringing upon it.

With some of the statements I should like to take issue Mr. Douglas says:

"If you take upon yourself the authority to specify in detail just exactly how a contractor is to proceed with the work, do not then specify that the contractor shall be responsible for the work."

This is out of accord with the whole trend of his paper. If we are not to specify just how the work is to be done, what is the use of all that he has written? What is the use of an inspector on the work if there are no rules for him to enforce? There is danger in taking a contractor's guarantee in lieu of laying down strict rules which he can and should follow.

As an example of what might be done where specifications are only general and dependence is placed on the contractor's responsibility, suppose a manufacturer has made a cast-iron base, and, finding upon taking it out of the mold that it has a large hole in it, he pours this hole full of metal. He has used his own way to accomplish a thing and probably has not violated his "general" specifications. He could in many instances with impunity guarantee that the base will not fail within a year. It might never fail, but the purchaser has not received what he is entitled to, and all because the manufacturer has not been restrained in his way of reaching an end by his own method.

There are endless ways in which a contractor, if allowed to use his own judgment, can vitiate the engineer's plans. If a contractor takes exception to a specified method of procedure as not being the one that his experience shows to be the best to secure the desired result, he need not take the contract and the responsibility. His exception should be given weight, but to leave him free to choose his method with no further stipulation than that he produce good work is to work from the wrong end entirely. The time to make sure of getting good work is while the work progresses. It is impossible to make it good after it is finished. Nothing but a botched job could result from hind sight in concrete work.

No inspector can get good work out of a poor plant and inefficient workmen, and it is herein that the contractor's responsibility rests. Good rules, enforced, enhance the contractor's chances of producing good work; and engineers may as well dispense with technical training if they are going to leave everything but results to the contractor.

A good place to see the difference in working between "general" specifications for good work and detailed specifications covering every step is to compare a bridge built for a board of county commissioners and one built under the supervision and inspection of an engineer whose business it is to see that the detailed specifications are carried out.

Mr. Douglas advocates a 1:2:3 concrete and 300 lbs. per sq. in. in compression for reinforced concrete. Concrete of the proportions of 1:2:4 has mortar enough to fill voids to the extent of 50% in the broken stone, and the usual percentage is about 30 to 40%; why the large excess of mortar? Concrete of these proportions made of good materials will stand 2,000 lbs. per sq. in. or more in compression after a few months; why stress it to only 300 lbs. per sq. in.? Such stresses would be practically prohibitive in lots of work. It is a curious coincidence that on the page on which Mr. Douglas states the unit he would use there is a cut of a girder that would be good for about one-half of its own dead weight at this unit, leaving out the 3-in. slab in the calculations as well as the longitudinal steel rods near the top, both of which add an uncertain amount of strength to the girder. In a modest twelve-story building, with columns spaced 20 ft. apart, the first-story columns would be nearly 5 ft. in diameter at 150 lbs. total load per sq. ft. on each floor. The pyramids of Egypt might have served some purpose, but they would not do for office buildings, because the room is nearly all on the outside.

If there is any ground for using 300 lbs. per sq. in. in reinforced concrete on account of possible bad work, this is a strong argument for an inspector constantly on the work, and for a good big stick in the hands of the inspector in the shape of good rules stating in detail what is to be done and what is not to be done, with authority to enforce them.

Yours very truly, Edward Godfrey.

Monongahela Bank Bldg., Pittsburg, Pa., Dec. 22, 1906.

[Not Mr. Douglas but the printer's devil invented the 1:2:3 mixture of concrete. The author wrote "1:2:5 concrete." Mr. Godfrey's criticism of the wasteful richness of mixture advocated, therefore fails.

Proof of the above letters was sent Mr. Douglas, who comments on them as follows.—Ed.]

Sir: In answer to Mr. Schaub's letter I wish to state that it is my opinion that "restrained" hooped columns may be used with higher stresses than 400 lbs., but I doubt if such columns will be found economical. Of course where a column of small cross-section is mandatory the use of heavily hooped columns is justifiable. A restrained concrete is a new idea to me, so that I am unable to express an opinion, except that if the system can be economically developed it will mark a new step in concrete-steel design. The use of stirrups tends to restrain the beam concrete, similar to hoops in columns.

It is to be borne in mind, however, that small cross sections of concrete heavily reinforced with steel are expensive. Contractors, however, seldom allow enough in their estimates for this class of concrete. Their practice is to figure reinforcement at so much per pound, and concrete for beams, columns, etc., for so much per

cubic yard. As a matter of fact, heavily reinforced concrete costs a good deal more per cubic yard than highly reinforced concrete. This additional expense is due to the difficulty of getting the reinforcement in to the form, the difficulty of holding it in position and the difficulty of placing the concrete within narrow forms, already choked with steel. Again, the more steel you have the greater probability that you will not get your concrete as compact and your steel as well encased.

Contracts are generally awarded to the lowest bidder, and the lowest bidder on this class of work is often a man without experience, who doesn't realize what trouble excessive steel gives.

Mr. Edward Godfrey criticizes the following statement of my article on Practical Hints for Concrete Constructors: "If you take upon yourself the authority to specify in detail just exactly how a contractor is to proceed with the work, do not then specify that the contractor shall be responsible for the work." I believe that 60% of the specifications in my files were not written by engineers experienced in the various details which they have covered in a general way, and I do not believe that as many as 60% of these engineers had sufficient time, assuming that they had the experience, to go into small detail before the contracts for the work were awarded.

I may be in error as to this, but I am, at any rate, certain that nearly all of the *well-drawn* specifications in my files are ones which are *general* and therefore elastic. Only important items of construction being referred to in detail, this is particularly so as to methods of procedure. The general specification may not be the best specification, but it is, as a rule, the only specification which is practicable, time and experience being considered. With a specification of this class, the contractor has more or less leeway in constructing the work and may properly be held responsible in part, at least, for the resulting work.

Of course, the best specification is a detail one, drawn by an engineer or engineers experienced in the various classes of work covered by the specification, it being assumed that these engineers are really specialists in the class of work covered and that they have ample time to consider each specified detail with care. With a specification of this class, the contractor should be made to construct the work in accordance with the specifications under the directions of experienced engineers and experienced inspectors. I do not believe that under such circumstances the contractor is equitably or legally responsible for the results, he having carried out the specifications in their entirety.

However, this last statement is not meant to be taken without some consideration of the many minute details which are never covered by the specification, but which the contractor must observe to insure acceptable work. These thousand and one minute details, cropping out as the work progresses, are vital to good work, but no specification however exquisite can be made to cover them; they can possibly be inferred from the specifications, but as a rule these minute details are covered by such clauses as "first-class work" or "common practice," and such clauses, like all other items of a specification, must be interpreted on the basis of common sense. The contractor's responsibility, under a detailed specification, depends upon the unwritten specifications of the contract which are covered by good practice alone. For instance, no engineer specifies the kind of steel of which the form tie-rods must be made, nor does he specify the kind of weld or the grade of mechanic who shall make the welds. He does not specify the number of threads per inch at the ends of the tie-rods or the sizes of the washers and nuts, and so on ad finitum. All these items are a matter of common sense and common practice, and the contractor is alone responsible for the work in so far as such detail is concerned.

Now, my position is this: that if your specifications are thoroughly detailed and these specifications are carried out under the direction of your inspectors, in so far as the results of the work depend upon these specifications the contractor should not be held responsible for final results.

If, however, the contractor fails to conduct his work, in so far as the minute unwritten details of specifications are concerned, in accordance with common practice, then in so far as such violation to common practice is detrimental to the work the contractor is responsible.

For instance, if the forms are covered by specifications in detail as to the number of square feet of concrete to be carried by a single tie-rod, and the contractor elects to use badly welded tie-rods, so badly welded that the tie-rods fail under reasonable strain, causing the forms to bulge, so as to seriously injure the work, then the replacement of the damaged concrete would be at the contractor's expense. But if the contractor were to build a piece of work in accordance with the engineer's design, specifications and where the unwritten details were in accordance with common practice, and this work should fail, due to poor foundation and bad design, bad judgment in the selection of materials, bad method of construction, wind or freshet, the contractor should not be held responsible for the work, he not having had any discretion in the matter.

Again, if you mold an ornamental balustrade, furnish design, specify materials, method of casting, kind of forms, etc., and see that the contractor carries out your orders in detail, is the contractor responsible if, in setting up the contraction of the concrete causes the bases of the balusters to crack off from the shafts? If the design, materials or method specified make the casting impracticable, is the contractor to blame?

I do not mean that the mere presence of inspectors on the work relieves the contractor from responsibility. On the contrary, no number of inspectors can keep a bad contractor from doing bad work. Inspectors can only keep track of the work in a general way. Suppose a batch of concrete was to get by the inspector without cement in it. The contractor would still be responsible for the work, he not having carried out the specifications.

The statement criticized by Mr. Godfrey is aimed at the practice of inexperienced engineers writing specifications for work replete with specified details copied at random from the standard specifications and not really applicable to the work. Such specifications make a good showing on superficial inspection, but the clause referred to in my statement is frequently sufficient evidence that the writer of the specifications has not confidence in his own judgment.

Large contracting firms have their own engineers to help keep them out of trouble. They will not bid upon work where the unit stresses are absurdly high, the details unsafe or where the specifications will result in bad work, but the small contractors seldom consult experienced men and the result is too often disastrous. Contractors frequently tell me that they do not consider the details incorporated in the specifications when they make their bids because specifications are never enforced. There is so much truth in this, even in my own work, I must admit, that I am constantly trying to so simplify my specifications that each day I can pass upon the details of construction with more or less freedom of action and without violating the spirit of the specifications. Specifications must be elastic or when you get on construction work you will find yourself hampered at every step by too much specification and the result is: specifications will not be enforced.

A man who writes detailed specifications must have a lot of experience on the specific work which he is writing about. If he has not he will find that he is tying himself up so badly that the contractor may well say, when he wants to neglect some vital item in the specification, "We have not been following the specifications, why now?"

Mr. Godfrey's criticism of the 1:2:3 mixture is of course a good one, but the editor has very kindly relieved me of any responsibility for this mixture which, of course, should be 1:2:5.

I agree with Mr. Godfrey's statement that 1:2:4 concrete will stand 2,000 lbs. per sq. in. or more in a few months, and I think for ordinary concrete work with the average materials available for concrete work throughout the country, 2,400 lbs. might be safely used in figuring the ultimate value of our concrete in compression. Assuming that this is so, 400 lbs. working stress gives us a factor of safety of 6, which is low enough for such a structural material as concrete. It is my judgment that, under ordinary conditions, good inspection being assumed, an engineer has no right to assume a higher ultimate crushing value than 2,400 lbs. at the end of six months. It is unquestionably possible to get concrete of a higher compressive value than this, but by so doing an engineer must have a better grade of materials and mechanics than is commonly in the market and must have experienced inspectors who will overlook every detail of the mixing and placing of the concrete, and this means higher prices per cubic yard than is commonly paid for concrete work. Of course, the contractor who is going to bid on the work should know that the engineer expects of him a higher grade of work than is commonly being executed. Under such circumstances, I do not believe that it is inadvisable to stress your concrete as high as 500 lbs. per sq. in., but this, in my judgment, is the highest stress the concrete should receive with our present knowledge of the material. However, the concrete engineer should not be willing to design beams and columns, particularly in building construction, with a lower factor of safety than 6 (six). There are, of course, some exceptions to this rule where human life is not jeopardized or large financial interests affected, and where the failure of a single column or beam does not mean the failure of the structure.

Any system of concrete steel design which prevents the flow of the concrete understrain permits of a somewhat higher unit stress than is mentioned herein, but I do not believe that the heavy reinforcement necessary under such a design means economy, as already remarked.

Yours truly,

W. J. Douglas.

Engineer of Bridges, District of Columbia.

Washington, D. C., Jan. 3, 1907.

To Divide a Semi-circle into an Equal Zone and Segment.

Sir: The problem, "To divide a semi-circle into an equal zone and segment," which appeared in the Engineering News of present date, might be solved as follows:

Trautwine's Engineer's Pocketbook, 18th Edition, Page 187, contains a table of areas of circular segments, giving, for each value of $\frac{\text{rise}}{\text{diameter}}$ from 0.001 to 0.500, the corresponding value of $\frac{\text{area of segment}}{\text{diameter}^2}$.

Mr. True requires the rise, $(r - p)$ of a segment whose area $= \frac{1}{4}$ area of a circle $= \frac{1}{4} \pi r^2 = \frac{1}{16} \pi d^2$. Here, therefore, $\frac{\text{area of segment}}{\text{diameter}^2} = \frac{1}{16} \pi = 0.196350$. For this value the table mentioned gives by interpolation, $\frac{\text{rise}}{\text{diameter}} = \frac{r - p}{2r} = 0.29802$. Hence $p = 0.403972\ r$.

Yours truly, Clinton L. Bogert.

257 South Fourth St., Philadelphia, Pa., Jan. 10, 1907.

[A correction should be noted in the geometrical solution of the above problem in last week's issue. The second equation should read

$$\text{Area sector bcd} = \frac{r \text{ arc bd}}{2} = \frac{r^2 \sin^{-1} \frac{x}{r}}{2}$$

The final equation then becomes

$$\frac{\pi r^2}{8} = \frac{x}{2} \sqrt{r^2 - x^2} + \frac{r^2 \sin^{-1} \frac{x}{r}}{2}$$

—Ed.]

ANNUAL MEETING OF THE NEW ENGLAND WATER-WORKS ASSOCIATION.

The annual meeting of the association was held at Boston on Jan. 9. After the lunch, which precedes the regular monthly winter meetings of the association, a brief address was made by the retiring president, Prof. William T. Sedgwick, of the Massachusetts Institute of Technology. He stated that such associations originated some 300 years ago at Rome, where a body of students formed the society of "The Lynx," which was devoted to scientific discussions. This was followed in due time by the Royal Society of England, the French Academy, and other organizations.

The growth of the total membership of the New England Water-Works Association during the past year, from 645 to 684, shows that the association is holding its own, particularly in view of the fact that never before were there so many invitations being sent out to join societies. The large membership is also an indication that the society is more than local in character. The retiring president laid stress on the importance of the social features of such societies, including particularly the interchange of ideas in private conversation at the meetings and the presentation of brief papers on practical every-day subjects of operation.

Though dealing with sanitary matters, Professor Sedgwick said that the association often met under most unsanitary conditions. This statement led up to the inquiry whether it was not time for the various engineering and scientific societies of Boston to join in the erection of a building of their own, adapted to their needs, one of the notable features of which should be provision for ventilation of the meeting rooms.

Legislative matters received the attention of the association during the past year. A proposal before the Massachusetts Legislature to permit boating on the "great ponds" of the State was successfully opposed as being a menace to the water supply interests of the State. The association had also passed resolutions favoring the restoration to the U. S. Geological Survey of its full appropriations for stream gagings and other hydraulic work; and it had also passed a resolution in favor of providing a forest reserve in the White Mountains.

Water power, as well as municipal water supplies, Professor Sedgwick urged, should be given attention by the association.

Mr. Willard Kent, Secretary of the association, reported a net gain in membership during the year of 39. The report of Mr. Lewis M. Bancroft, Treasurer, showed a balance on Dec. 31 of $3,411, most of which is drawing interest. Mr. Charles W. Sherman, M. Am. Soc. C. E., Editor of the Journal, reported that there had been

published during the year 495 pages of the Journal, at a net cost, after deducting receipts, of $387. The cost of the Journal per member for 1,000 pages of text was 88 cts.

The tellers reported the election of all the officers suggested by the nominating committee, including the reelection of Messrs. Kent, Bancroft and Sherman to the offices of secretary, treasurer and editor, respectively; the election of Mr. John C. Whitney, Water Commissioner of Newton, Mass., as president, and the following vice-presidents: Messrs. M. N. Baker, of New York; G. H. Snell, of Attleboro, Mass.; F. C. Coffin, of Boston; George A. King, of New Haven; H. T. Sparks, of Brewer, Me.; and Joseph M. Birmingham, of Hartford.

A paper on meter registration was read by Mr. Arthur N. French, Superintendent of the Hyde Park Water Co., Hyde Park, Mass. Mr. French's paper and the discussion which followed it might have been named "Meter Idiosyncracies," but both the paper and the discussion brought out very clearly the fact that on the whole the water meter, as a somewhat complicated mechanism subject to hard usage, is remarkably satisfactory. Mr. French cited a number of cases of meters on his water-works system which had registered when no water was passing through them; or, more properly, when no water was being drawn through the services with which they were connected. This apparent contradiction was due to the formation of pumping surges in the distribution system and the formation of air cushions in the house-pipe system with which the meters were connected. The water in such instances passed through the meters and then back again, and as the meters were of a kind that could not register backward they indicated a consumption of water when none had actually occurred. After puzzling over various instances of this kind and verifying the allegation of the consumers to the effect that their meters were registering when no water was being used, Mr. French made some experiments with different classes of meters which cleared up the whole subject. Mr. French and other speakers cited instances of curious freaks in the registering of meters, due to displacement of the gears, the breaking of gear teeth, etc. The occasional failure of a meter to register beyond a certain number was explained by a clogging of some one of the gears so as to make all the gears that acted before it serve as a spring until sufficient energy was stored to exceed the breaking point of the metal, whereupon a tooth would break off and the strain be relieved. Thereafter, whenever the same quantity was again reached the proper unit in the gearing of course failed to register.

It was pointed out by several of the speakers that placing a check valve would prevent some of the curious happenings that had been recited during the discussion. One member had found it worth while to insert two check valves in order that one might be taken out and cleaned after clogging, it having been shown that the first check valve clogged refused to work, whereupon the meter resorted to its old tricks.

To give some variety to the usual run of proceedings, a brief address on hydrophobia was made by Dr. Langdon Frothingham, of the Hartford Medical School, in response to a request by Professor Sedgwick. An address on the subject was considered timely, in view of the fact that hydrophobia, or rabies, is very prevalent throughout Massachusetts at present, and also extends into Rhode Island and Connecticut.

The proposed paper on sanitary protection of watersheds, by Mr. W. W. Locke, Assoc. M. Am. Soc. C. E., was not presented, Mr. Locke not being present at the meeting.

FIG. 2. INTERIOR VIEW OF THE HOLLAND SLEEPING CAR FOR THE ILLINOIS ELECTRIC TRACTION LINES.

(The chairs are shown as arranged for use as a parlor car by day. At the right are some of the partitions drawn to form the sections or rooms.)

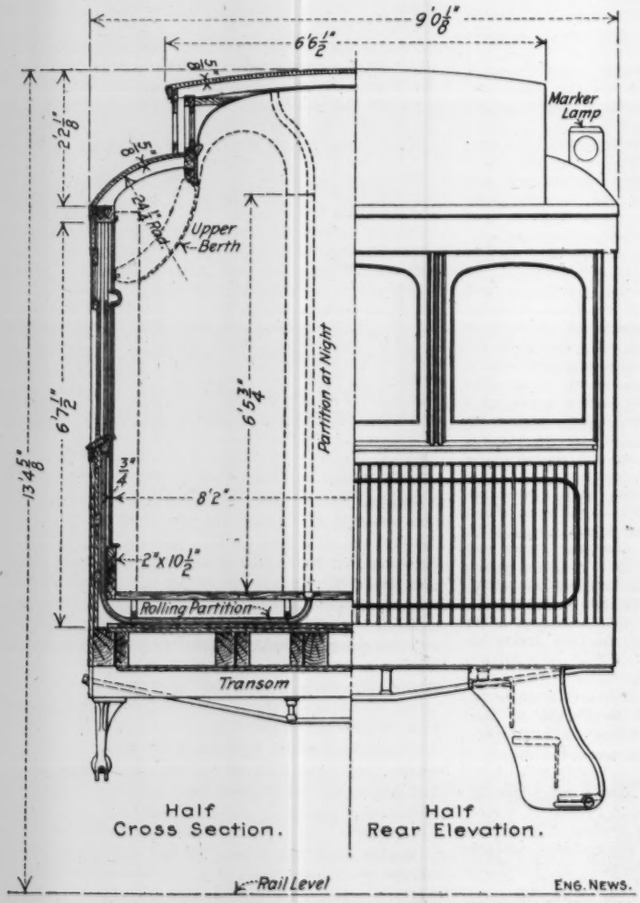


FIG. 1. PART CROSS-SECTION OF THE HOLLAND SLEEPING CAR; SHOWING THE ARRANGEMENT OF ROLLING PARTITIONS.

SLEEPING CARS FOR ELECTRIC INTERURBAN RAILWAYS.

The development of interurban electric railways has resulted in the formation of numerous long continuous routes, owned either by a single company or by companies operating in harmony so as to provide facilities for through cars. The introduction of sleeping car service on these long runs has been suggested at various times, and such a service was in fact tried several months ago on some lines in Ohio. The intention was to operate cars between Indianapolis, Ind., and Columbia, Ohio, a distance of about 188 miles, but for some reason this service was never put into operation, although the cars were operated as parlor cars on the Newark & Zanesville and Dayton & Lima interurban lines. The idea has now been taken up by the Illinois Traction System, and Mr. L. E. Fischer, General Manager, informs us that it is expected to start a service of sleeping cars between Decatur, Springfield and East St. Louis about the end of December. This is a trolley line. The cars used in all the cases referred to above are of the Holland type, and were built for the Holland Sleeping Car Co., of Indianapolis. In January last, however, the Marion Trust Co., of Indianapolis, was made receiver for the sleeping car company, and in August the cars were sold to the Walter A. Zelnicker Supply Co., of St. Louis, Mo. They were built about two years ago by the Harlan & Hollingsworth Co., of Wilmington, Del.

The exterior appearance is similar to that of the modern type of interurban car, but the interior arrangement is of special design and presents two principal features of interest. In the first place it enables the car to be utilized as a parlor or chair car by day and a sleeping car by night. In the second place the arrangement of the sleeping accommodation possesses some advantages over the ordinary type of Pullman sleeping car. The main saloon of the Holland car has 20 revolving chairs, arranged as in an ordinary parlor car, but having the backs of rectangular form. At night the backs of the

chairs are folded down, each pair forming a lower berth. Portable posts are set up and form guides for rolling partitions, which are drawn out to form five staterooms or sections on each side. In each section is an upper berth, let down from the roof in the usual way. Each section is 6 ft. 10 ins. × 3 ft. 4 ins., with berths 2 ft. 2 ins. wide, leaving a space of 1 ft. 2 ins. between the berths and the partition, so that passengers have a chance to stand up and dress. These dimensions may be modified in later cars. In ordinary sleeping cars the berths are the full width of the section and the curtains hang against them, so that the passenger has no place to stand. And while in the Pullman cars the sections are shut off from the central passage by curtains only, in the Holland cars there are partitions, with an opening to each section closed by a curtain, so that there is greater convenience and also greater privacy for the occupants. All the partitions are wooden roller curtains, which lie under the floor by day, as shown in the cross-section, Fig. 1. The interior view, Fig. 2, shows some of the chairs in place and some of the sections made up as for night. The partitions are faced in the inner side with decorative material.

At the front of the car are the motorman's room, porters' lockers and women's toilet room. The main saloon is 34 ft. 2 ins. long, and at the rear of this are the smoking room, heater compartment and men's toilet room. At the extreme rear is a vestibuled entrance, with side doors. The car is 56 ft. 6¾ ins. long over the bumper beams, 8 ft. 9½ ins. wide over the side sills, and has a height of 13 ft. 4⅝ ins. from rail to top of roof, while the inside height is 6 ft. 6 ins., exclusive of the monitor roof. It is mounted on trucks having 33-in. wheels and a wheelbase of 7 ft.; the trucks are 35 ft. 9 ins., c. to c. On each axle is an electric motor of 150 HP., the car being designed for speeds of 60 to 70 miles an hour. The main framing consists of six longitudinal sills, each composed of two timbers, 3½ × 3½ ins., with a ½-in. steel plate 3½ ins. deep sandwiched between them. The frame is stiffened by two truss rods. The car has electric lights and fans, an electric arc headlight, Consolidated electric and Smith hot-water heating systems, and air brakes.

The total weight is nearly 100,000 lbs., which is certainly excessive for a 20-berth car, and we are informed that the weight of the cars was one objection to their use on the lines for which they were originally intended. It must be remembered, however, that the cars were built partly to advertise the new system of construction, and were therefore made very elaborate. Nearly half of the weight is represented by the trucks and their power equipment, owing to the high speeds at which it was proposed to run the cars. Such speed capacity, however, is not at all necessary. It is probable that similar cars could be designed with less elaboration and lighter power equipment that would be better adapted to the conditions of service.

COMMERCIALIZED ENGINEERING.*

"Talk about commercialized politics," said a civil engineer the other night, "or the commercialized theater, or press—why, none of them can hold a candle to commercialized engineering." In explanation, he averred that his profession is suffering from the evils of monopoly. A few great corporations—in electrical engineering there are practically but two—not only control nearly all the work done, but dictate the technical methods to be followed. The result is the raising of almost insuperable barriers to new men and new ideas; the practice becomes routine and stodgy; the absence of real competition works the same harm to engineering that it does to any other pursuit.

We know that this point of view is not isolated. Many engineers would agree in general with the impetuous critic whose language is cited above, even if they might regard his indictment as too sweeping. On the professional side, it is a matter for engineers themselves to discuss. What the relations of special talent should be to employing corporations, what the obligations of a man to the severe demands of science when they are in conflict with mere money-making—these topics can be most fruitfully debated by those set for the maintenance of a high standard of engineering ethics. But the public is deeply concerned in the practical effect of it all. If engineering has become so commercialized that we are not getting the best possible work, it is of the highest consequence that we should know the causes and find, if possible, the remedies.

The process of setting about any large electric undertaking, for example, is pretty well known. Promoters and their engineers have to go to "headquarters"—we mean, to one of the two great corporations which are gradually absorbing the more important business of this sort. They are, admittedly, excellently equipped. No one so ready to "handle" an attractive scheme. But first, of course, you must get engineering approval—meaning their own engineers. Next, you will be referred to a subordinate company of theirs, which is designed to look after the finances. Thus one hand washes the other. To get the backing of the big corporation, you must previously find favor with a certain firm of engineers, and also make arrangements to float your securities through a given bond and stock concern. This makes the business very complete, to be sure; puts at the disposal of the inquirer facilities which he could find nowhere else; but the questions of cost, excessive or otherwise, and of getting the best obtainable practice, remain to be considered.

We will say nothing of financial complications, though it is obvious how easily they may arise. As outsiders, we are more concerned with the practical result of this commercial organization of engineering, with its inbreeding of talent and its stereotyping of method. It is easy to see, theoretically, that the tendency would be to make even able technicians lazy and perfunctory. Why should they bestir themselves, so long as no competitor is in sight to show the better way and take their work away from them? Monopoly is the great discourager of effort. We may be sure that it will work its deadening effects in a profession as fatally as in trade or manufacture. If pressure from without does not compel the adoption of the most advanced methods, and the putting out of the finest possible product, professional pride will prove an inadequate motive. The only way in which to make even highly trained men get out and hustle, is to pit them against others who will take their jobs from them if they are not on the alert.

The matter comes closely home to the bosoms of New Yorkers in the continually agitated questions about the equipment of the Subway. Is it the best that could have been devised? In one particular, at least, the answer of the man in the street is exactly the same as that of independent and competent engineers. The pattern of car adopted—especially the wooden cars, with their narrow platforms making a perfect cul de sac for the crowds—was far from the best that could be had. They were far inferior to the cars already in use in the Boston Subway; they profited not in the least by the experiments of the Illinois Central, for example, in building a type of car fitted to handle the large surburban traffic at Chicago. In a word, the model taken for the Subway was practically obsolete. Its inadequacy could have been foreseen before a single car was set running.

Now, how did this serious mistake come to be made? We speak from no personal knowledge, but we only report the opinion of impartial and skilled men who have looked into the matter, when we say that the root of the trouble was the stolid sense of monopoly on the part of the company furnishing the equipment. They had no rivals to dread; they had their own standardized methods of manufacture, and did not propose to depart from them for the public convenience. What their engineers might have suggested, their financiers vetoed. If this be true, it is certainly a lamentable demonstration of the vices of commercialized engineering.

*Editorial in the New York "Evening Post" of Jan. 4.

THE WORK OF LARGE ENGINEERING ORGANIZATIONS.

By Charles Day,† M. Am. Soc. M. E.

The phenomenal development which the industries of this country have undergone within the past decade has brought into existence, a number of concerns who are practising engineering along the most comprehensive lines. I propose to refer briefly to this particular field of work.

We will assume that such concerns desire to handle from start to finish complete operations including industrial plants, street railways, power plants, etc. In order to serve their clients properly, their work should conform to three fundamental requirements, which tend to establish conditions favorable to our ethical standard. First, work should not be undertaken unless it is of understood utility. Secondly, the engineering organization must possess reasonable competency for its complete accomplishment. Thirdly, they must be adequately and surely compensated for services rendered.

The essence of service rendered by such an organization arises from the acceptance of the entire obligation incident to the operation, and will not permit a partial answer to any question. Service of this kind cannot possibly be rendered by an individual, nor can we ever hope to provide within a single organization men of the attainments required to reach the best possible result from the standpoint of all existing knowledge. In the main essentials, however, essentials which in the past have too frequently been given no consideration by the engineer, the client's interest can be properly guarded and the operation, considered as a whole, can be well handled.

The matter of compensation should, if possible, be finally adjusted before undertaking any work, and I think that the matter of ethics can be more surely benefited through attention to this than in any other way. We cannot deny the general conclusion that the mental attitude of our engineers depends largely upon the conditions under which they work. The rate of compensation for engineers who work upon a percentage basis has been established by those who have gained high proficiency in their line, whose volume of work and perfection of system secure a minimum of cost, so a fee that may assure a reasonable return to them, proves quite inadequate for the majority of those practising in parallel lines. There is very little consistency in the usual basis of compensating engineers and architects, and many of the evils connected with these professions arise directly from this cause.

Such an engineering concern as we are discussing however, must not make this mistake, but must insist upon a fixed sum as profit, the amount of which should be known to the client before undertaking the work. Those who have once established a method of charge based upon actual cost of the work plus an agreed profit, find that they can secure the usual engineering commissions upon an equally favorable basis, and it would be well for the consulting engineers the country over to appreciate this fact. Concerning the competency of the engineering organization that we are considering, much could be said. Having become assured that a given operation is of direct utility and having arranged a contract for handling the work that provides adequate compensation for services rendered, there should be little or no incentive to depart from the proper ethical course provided the necessary competency for the fulfilment of the contract exists. The moment this is not the case, however, the client's interests are being but imperfectly served, but here we encounter a nicety of judgment requiring a master hand, as the question of competency is entirely relative. This fact must, however, be ever kept in mind by the engineering firm, and they should stand ready at any moment to admit the need of calling upon the outside for further enlightenment.

When acting as an agent, the individuals of such an organization must not only be men of high integrity, but they must possess the power to analyze their own motives with a view to making them ever subservient to the needs of the client. Men possessing such ability can use it to the great advantage of those for whom they act, but the same ability applied for one's own interests (in the capacity of salesmen, for example) would probably bring results not compatible with the high ethical engineering standard we desire.

The services rendered by such an engineering organization, cover all construction as well as the engineering features, and in fact, this policy upon the part of the pioneers in this field is tending to rapidly elevate the standing of contracting work. Many of the ablest contracting firms now engage thoroughly competent engineers and the old policy of treating the contractor with suspicion is rapidly giving way to the necessary spirit of coöperation.

Some years ago an engineer practising in a consulting capacity could cover with a fair degree of thoroughness the varied propositions brought into his office, but this is no longer possible. It is acknowledged by all, that we cannot hope to attain competency in more than a comparatively narrow field of work so that it is but natural that such experts should be brought together under a single administrative head.

Here then is a field of engineering that I feel sure is going to assume much greater importance as time goes on, and I further believe that a high standard of ethics will accompany its growth, as it is founded upon substantial principles requiring no concealment or subterfuge on the part of any one involved.

*Extract from a paper read before the Philadelphia branch of the American Institute of Electrical Engineers, Dec. 10.

†Of Dodge & Day, Engineers, Drexel Building, Philadelphia.

THE USE OF SMALL PUMPING PLANTS IN CONNECTION WITH SEWERAGE SYSTEMS.

A number of brief papers and addresses on the use of small pumping plants in connection with sewerage systems were presented at the meeting of the Sanitary Section of the Boston Society of Civil Engineers on the evening of Jan. 9. Mr. I. F. Farnham described a small sewage pumping plant at Newton Upper Falls. The plant is a temporary one, designed for use pending the construction of a gravity outfall sewer. The plant was put in operation in 1903 and serves 30 houses with a population of about 160, and a

machine shop with a population of some 600. There are two 3¼-in. submerged centrifugal pumps driven by two 6-HP. gasoline engines. Either engine can operate either or both pumps and both engines can, if desired, be connected to one pump. The maximum lift is 30.7 ft. The contract capacity was 150 gals. per min. and the test capacity was 210 gals. The plant is located near the water-works pumping station and is attended by a fireman in the latter. An indicator in the water-works pumping station shows when the small reservoir connected with the sewage station has filled. When the indicator works, the fireman goes to the sewage station and starts the pumps, which shut down automatically. The cost of this plant, including the pumping station, force main, etc., was $6,700, and the yearly cost of operation has averaged between $400 and $500. On the whole, the plant is very satisfactory. The most serious trouble has been due to human rather than mechanical defects. No emergency overflow is possible, and once or twice the pumping station has been flooded. No screens were provided when the pumps were started, but trouble with clogging by cotton-waste led to the installation of basket screens.

Mr. F. A. Barbour, M. Am. Soc. C. E., of Boston, read a paper in which he described a number of sewage pumping plants which he had designed. He stated by way of preface that labor was the chief problem in connection with these pumps. In order to minimize the attendance on the pumps, automatic features are introduced where feasible, for which and other reasons the pumps are frequently divided into small units. After describing the Saratoga installation (Eng. News, Feb. 2, 1905) Mr. Barbour took up in succession the plants at Hudson, Mass., Fredericton, N. B., Atlantic City, N. J., and elsewhere. Two small electrically-driven centrifugal pumps at Hudson, with a normal combined capacity of 500 gals. per min. against 35 ft. head, were installed at a cost of $3,600 for pumps, motors and piping. At Fredericton a plant of the same capacity but operating under a lower head is being put in, to pump the sewage when the river rises above the outfall. The cost of this plant will be about $3,000, including a considerable percentage for import duty. At Atlantic City a number of electrically-driven pumps will be located beneath the sidewalk, with no structures above the surface.

Mr. C. O. Rogers, of the Charles J. Jaegar Co., and Mr. F. H. Hayes, New England manager of the Platt Iron Works, were present and spoke by request. Among the practical suggestions made by Mr. Rogers was one to the effect that in these small installations reliability of service was of far more importance than low operating cost. In response to a question as to the minimum size limit for a centrifugal pump, Mr. Rogers stated that at the Newton Upper Falls plant a 2-in. pump would have been sufficient, so far as mere capacity was concerned, but it was considered desirable to make liberal allowance for clearance to avoid clogging and therefore a 2½-in. pump was provided. The latter was considered a limit for a municipal plant. Mr. Hayes referred to the 5,000,000-gal. electric sewage pumping plant at Pittsfield, Mass. (see Eng. News April 24, 1902, article on sewage works), and stated that this company now has a duplicate order for an 8,000,000-gal. pump at these works. It is also about to install a 2,000,000-gal. electrically-driven duplex piston pump, to work alongside similar but steam-driven pumps at South Framingham, Mass. Good prices have been obtained for electric current where it has been possible to arrange pumping plants, so that they were operated in the daytime only. In answer to some questions raised as to the length of time that sewage pumps could be left to take care of themselves, Mr. Hayes expressed himself quite strongly to the effect that such pumps should preferably have attendance every three or four hours.

Mr. L. D. Thorpe described two sewage pumping plants built at Charlottetown, P. E. I., in 1898 and 1900, respectively. These serve two different sections of the city and include low-lift centrifugal pumps driven by 7-HP. horizontal Otto gas engines. Mr. Thorpe operated these pumps himself for about a year, and frequently left them entirely to their own devices for three or four days at a time without experiencing any complications.

Mr. A. J. Gavett, City Surveyor of Plainfield, N. J., sent a brief communication, in the course of which he stated that a contract has just been let to the Ingersoll-Rand Co., of New York, for a sewage pumping plant to serve a small section of the city. An air compressor, driven by a Wagner electric motor, will operate pneumatic displacement pumps, and a gas engine will be provided for emergency use in cases of interruption of electric power.

Reference was made in the course of the discussion to four electrically-driven centrifugal pumps which will be used in connection with the new Salem outfall sewer, and also to an electrically-driven plant now being built at Waltham.

Throughout the discussion repeated references were made to clogging due to cotton-waste, the plants involved evidently being located in manufacturing towns. This clogging, it was stated, could be prevented by the introduction of screens.

ANNUAL MEETING OF THE AMERICAN FORESTRY ASSOCIATION.

The annual meeting of the association was held at Washington, D. C., on Jan. 9. The opening address was by the Hon. James Wilson, U. S. Secretary of Agriculture. In the course of his remarks, Secretary Wilson spoke of the need of planting 100,000 acres of trees a year as as high a rate as need be considered at present, but as altogether inadequate for the needed increase of forest area. He urged the necessity of the people of New England and the Southern States rallying to the support of the Congressional bills for the White Mountain and Southern Appalachian forest reserves, respectively.

An interesting address was made by Dr. Edward Everett Hale. The individual cannot afford to plant forests and wait for returns therefrom, but the State can, and should do so.

REPORT OF THE DIRECTORS.

The annual report of the directors of the association showed that as a result of the strong effort to increase the membership the number of names on the list had been increased from 3,094 to 5,543 during the year, notwithstanding the inevitable losses by withdrawals, deaths, etc. The total receipts from the new members was $13,325, against which is charged the printing and mailing of over 200,000 invitations to join the association, and office and other expenses, amounting in all to $9,929. This leaves an excess of receipts over expenditures on new membership account of $3,296. Included in the new membership expense is $1.17 per member for a copy of "Forestry and Irrigation" sent to each member.

During the year the national forests have been put under conservative management. Sales of timber during the calendar year aggregated $387,000, returns for grazing privileges $563,000 and other receipts brought the total revenues up to over $1,000,000.

Six large planting stations have been established where about 5,500,000 seedlings are now growing. The stations are located in Nebraska, Colorado, New Mexico and Utah. Two large stations are projected, and in addition it is proposed to establish 100 or more small nurseries under the care of forest rangers, to provide stock for local planting.

In reviewing the forestry work of one kind or another in progress or provided for by the several States of the Union, no less than 21 States were mentioned. Of these, New York has 1,500,000 acres of forest reserves and is planting 500,000 trees annually. Pennsylvania has 820,000 acres of forest reserves in several detached areas, and has recently doubled in size its eight nurseries. In the spring of 1905 it set out 160,000 white pine seedlings. New Jersey has purchased nearly 1,000 acres for forest reserve purposes. Indiana is steadily improving its 2,000 acres of forest reserve. Minnesota is preparing working plans for a reserve of 20,000 acres in St. ... County. Other States have established ... commissioners, nurseries, purchased and ... tributed trees, etc.

State forest associations now exist in ... Hampshire, Vermont, Massachusetts, Connecticut, New York, Pennsylvania, Ohio, Michigan, Iowa, Minnesota, Colorado and California. In Canada the Canadian Forestry Association has been organized and held two meetings during the past year.

The forest fire loss in the United States a few years ago was placed at $50,000,000. It is thought that the loss for 1906 would be covered by $5,000,000. In 1905 the burned areas in the national forests aggregated 279,000 acres, or less than 0.3% of the total area under government control. The appreciation of fire protection measures in Maine is shown by the fact that for the last two years the lumber interests of that State have maintained six mountain lookout stations in the Moosehead Lake region.

Forest education is progressing in a gratifying manner. No less than 16 institutions were mentioned in the directors' report as giving instruction in forestry.

WHAT THE FOREST SERVICE STANDS FOR.

An address on this subject was made by Mr. Gifford Pinchot, Forester of the U. S. Department of Agriculture, with the text, "The Forest Service Stands for Business Forestry." Mr. Pinchot stated that prior to the transfer of the forest reserves from the Department of the Interior to the Department of Agriculture he promised the House Committee that if the latter could have the right to charge for grazing the Forest Service would never ask for an annual appropriation of more than $1,000,000 and in five years would be self-sustaining. The first full year of control of grazing, the receipts from this source were $767,000. The receipts are increasing and promise to continue to do so, and it is expected that an appropriation of $900,000 will be sufficient for next year, with marked decreases after that.

Mr. Pinchot said that practical forestry can be made to pay, and that the Forest Service is determined to show that public as well as private interests could effect this desirable end.

On the subject of education in forestry and the need of trained foresters, Mr. Pinchot said:

> Another matter in which the Forest Service is interested is the support of education in forestry. It is striving to give help just so far as it can to the institutions scattered throughout the country—and they are very numerous now—which are taking up instruction in forestry, from either of two points of view. I wish to make this distinction here: there are preparatory schools, so to speak, in forestry, which do not prepare students in professional work, and there are professional schools whose business it is to turn out men ready to go to work in the first field. The great danger which threatens forest education now is that institutions which are well equipped to give the preliminary education should attempt to turn men out as professional foresters, when they are not really able to do so. The Forest Service is exceedingly anxious for a supply of men, and it is still more anxious that the men who come in should be thoroughly trained. Accordingly it is very solicitous that the schools which profess to give complete and professional training, should really be equipped for that purpose. And I must tell you in closing of the tremendous need that we have for men.
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> We have now, as you know, 127,000,000 acres in forest reserves. All of this is but a drop in the bucket compared with the total forest area of the United States, and but a small part of the forest which must be preserved if the results of forest preservation are to be achieved. We are doing pretty well with the Western mountains, but those Western mountains will not supply the National need. That must be done by the States and by private individuals, who will hold and manage their forests on scientific principles. Even in this comparatively small forest area, which the National Government holds, our forces are ridiculously inadequate. We have now, in the middle of winter, about 600 forest rangers and about 60 forest supervisors; that is to say, a force of about 700 men for an area which, if it were managed as it would be managed in Prussia, would have something over 15,000 forest supervisors and something over 117,000 forest guards. We have about 200 trained foresters to do the work which would be done in Prussia by 15,000. If we were to add a hundred men a year to our present force,

and each man appointed lived and worked to the end, it would take about a hundred and fifty years to get our reserves manned in the Prussian way. One of the very first demands of the present situation is for men. We realize that unless the forest schools can begin to turn out the trained foresters we need, we shall be unable to meet the rapidly increasing demands for men in the forest reserves to handle them properly. The only reason we can do it now is because the demand for products of the reserves is comparatively small. As the population increases, as people understand how to use the National forests more freely, and as roads and trails are built, the forests will be used ten, twenty, or a hundred times more than they are now; and when that time comes, unless we can have enough trained men ready for professional work on the reserves, we shall have an exceedingly hard job. Just one ray of light, in addition to the very hopeful fact that many forest schools have been established, shines from the prospect that Congress will give $2,000,000 to be spent on permanent improvements, roads, trails, telephones and fire lines, and with that sum of money will at least double the efficiency of our present force. When that comes about it will be altogether the most hopeful thing that has happened to us.

OTHER ADDRESSES.

Mr. Enos Mills spoke on "The Forest Situation in Colorado," which on the whole he considered to be encouraging. Mr. J. S. Palmer, Secretary of the National Slack Cooperage Association, pointed out the growing scarcity of woods suitable for manufacturing barrels or packages for flour, sugar, etc. He stated that the creation of the proposed Southern Appalachian forest reserve would be of benefit to the members of his association. Mr. S. T. Kelsey, a civil engineer, spoke of the relation of the proposed Appalachian forest reserve to floods and droughts. In a similar vein, Mr. George Ward Cook, of Haverhill, Mass., discussed the benefits to the Merrimac River drainage that would result from a forest reserve in the White Mountains. A paper on "Financial Results of Forest Management" was read by Dr. B. E. Fernow.

RESOLUTIONS AND OFFICERS.

Resolutions were adopted in favor of the Southern Appalachian and White Mountain forest reserve bills, which have already passed the U. S. Senate and are before the House Committee on Agriculture, in favor of providing the U. S. Forest Service with a working capital fund of $5,000,000, as recommended by President Roosevelt; in favor of the repeal of the U. S. Timber and Stone Act; in favor of an appropriation of $200,000 to establish a wood testing laboratory in connection with the Forest Service, and extending the thanks of the association to Mr. Pinchot for "his unselfish and untiring service in behalf of forestry in this country."

The following are the principal officers elected: President, Hon. James Wilson, Secretary of Agriculture; treasurer, Mr. Otto Luebkert, of the American Audit Co., Colorado Building, Washington, D. C. The office of secretary is filled by Mr. Thomas E. Will, 1311 G St., N. W., Washington, D. C.

SPECIAL MESSAGE OF PRESIDENT ROOSEVELT TO CONGRESS URGING ACTION FOR CLOSING THE BREAK IN THE COLORADO RIVER BANKS.

To the Senate and House of Representatives:

The Governor of the State of California and individuals and communities in Southern California have made urgent appeals to me to take steps to save the lands and settlements in the sink or depression known as the Imperial Valley, or Salton Sink region, from threatened destruction by the overflow of the Colorado River. The situation appears so serious and urgent that I now refer the matter to the Congress for the consideration, together with my recommendations upon the subject.

Briefly stated, the conditions are these: The Imperial Valley, so-called, in San Diego County, Cal., includes a large tract of country below sea level. Southeast of the valley and considerably above its level is the Colorado River, which flows on a broad, slightly elevated plain, upon which the river pursues a tortuous course, finally entering the Gulf of California. The lands in the Imperial Valley are 200 ft. or more below the level of Colorado River. Down as far as the international border they are protected from inundation by low lying hills. South of the boundary in the Republic of Mexico the hills cease abruptly and only the broad low mud banks of the river protect the valley from being converted into an inland sea or lake. In order to get any water to this vast tract of fertile but desert land, or, on the other hand, to protect it from too much water, works of supply or of protection must be built in Mexico, even though they may tap the river in the United States. The United States can neither aid nor protect the interests of its citizens without going upon foreign soil.

Nature has through many centuries protected this great depression from overflow, but the restless river, constantly shifting, has annually threatened to break through the banks. Only a little human aid was needed to cause it to do so.

WORK OF THE CALIFORNIA DEVELOPMENT CO.

This condition has been long known and through many years schemes have been discussed either to convert the Salton Sink area into a lake or to irrigate the desert lands below sea level by making a cut in Mexico through the west bank of the Colorado River. It was also well understood that if the cut in the bank was not carefully guarded the river would quickly get beyond control. Finally, after many plans had been tentatively tried, the California Development Co., a New Jersey corporation, actively undertook the work. To insure the safety of Imperial Valley the head of the canal on the river was first placed on United States territory near where the river was bounded by hills. The canal then swung southwest and west away from the river through Mexican territory to connect with natural depressions leading to the valley and back into the United States. The organizers of this company, in order to carry on the work in Mexico, caused to be created a subsidiary company in Mexico acting under Mexican laws. Concessions were made for the employment of a Mexican engineer to be designated by that government in order to see that the work was properly carried out. The dangerous character of the attempt was thus recognized in this concession.

The California Development Co. began its work by making representations to possible settlers of the great benefits to be derived by them by taking up this land. A large amount of money which might have been used in needed works was expended in advertising and in promoting the enterprise. The claims were not only extravagant, but in many cases it appears that wilful misrepresentation was made. Many of the operations of this company and of its subsidiary organizations tended to mislead uninformed settlers. At first the success of the company was great, and it disposed of water rights to settlers at prices sufficiently large to obtain a fair revenue, either in cash or in securities of value.

The money thus obtained from settlers was not used in permanent development, but apparently disappeared either in profits to the principal promoters or in the numerous subsidiary companies which to a certain extent fed upon the parent company, or served to obscure its operations—such as a construction company, a company to promote settlement, and a company to handle the securities of the various other corporations. The history of these deals is so complicated that it would require careful research extending through many months to unravel the devious ways by which money and valuable securities have disappeared. In brief, it is sufficient to state that the valuable considerations which were received for water rights were obviously not used in providing necessary and permanent works for furnishing water to the settlers.

The whole enterprise and the spirit of those promoting it, as well as of the numerous smaller speculators attracted to the subsidiary organizations, were of the most visionary character. Actual investments made have been small in proportion to estimates of wealth which appeared to be possible of realization.

The company entered upon its construction work with large plants but with inadequate capital. All of its structures for the control and distribution of water were temporary in character, being built of wood and of the smallest possible dimensions. Through the efforts thus made, a large amount of land was brought under cultivation, and at one time it was reported that over 100,000 acres were being more or less irrigated.

The first heading of the canal of the California Development Co. was in the United States immediately north of the Mexican border. It was found, however, after a time, that the heading on the United States side of the line did not give a grade to furnish a sufficient flow of water, and after headings had been opened at other points without successful results a cut in the river bank was made four miles further south, in Mexican territory. This gave the water a shorter and steeper course toward the valley. The making of this cut in a bank composed of light alluvial soil, above a depression such as this, without controlling devices, was criminal negligence. This short cut on Mexican soil was made in the fall of 1904. It was gradually eroded by the passage of the water, and in the spring of 1905 the floods of the Colorado River entering the artificial cut rapidly widened and deepened it, until the entire flow of the river was turned westerly down the relatively steep slope into the Imperial Valley and thence into what is known as Salton Sink, or Salton Sea.

WORK OF THE SOUTHERN PACIFIC CO.

After the mischief became apparent, strenuous efforts were made by the California Development Co. to close the break, but these were without success. Finally the Southern Pacific Co., finding its tracks imperilled and traffic seriously interefered with, advanced money to the California Development Co., received as security a majority of the shares of the company, and thus took charge of the situation.

By means of the facilities available to the Southern Pacific Co., the break in the west bank of the Colorado River was closed on Nov. 4, 1906. A month later, however, a sudden rise in the river undermined the poorly constructed levees immediately south of the former break, and the water again resumed its course into the Salton Sea.

THE IMMINENT DANGER OF THE PRESENT SITUATION.

The results have been highly alarming, as it appears that if the water is not checked it will cut a very deep channel, which, progressing up-stream in a series of cataracts, will result in conditions such that the water cannot be diverted by gravity into the canals already built in the Imperial Valley. If the break is not closed before the coming spring flood of 1907, it appears highly probable that all of the property values created in this valley will be wiped out, including farms and towns, as well as the revenues derived by the Southern Pacific Co. Ultimately the channel will be deepened in the main stream itself up to and beyond the town of Yuma, destroying the homes and farms there, the great railroad bridge and the government works at Laguna dam, above Yuma.

THE PROPERTY INTERESTS IMPERILED ARE IMPOTENT TO PROTECT THEMSELVES.

It is difficult to estimate how many people have settled in the valley, the figures varying from 6,000 persons up to as high as 10,000. It is also difficult to ascertain how much money has been actually spent in real improvements. Town lots have been laid off, sold at auction, and several hundred buildings erected in the various small settlements scattered throughout the tract. The greater part of the public land has been taken up under the homestead or desert entry laws, and sufficient work has been done to secure title. Some crops have been raised and under favorable conditions the output in the near future would be large.

The actual amount of tangible wealth or securities possessed by the settlers to-day upon which money can be raised is believed to be very small. Nearly all individual property has been expended in securing water rights from the California Development Co. or from other organizations handling the water supply and controlled by this company. It is evident that the people have slender resources to fall back upon, and in view of the threatened calamity are practically helpless. The California Development Co. is also unable to meet the exigency. Obligations assumed by the sale of water rights are so great that the property of the company is not adequate to meet these obligations; in other words, a gift of the visible property of this company and of its rights would not be a sufficient offset to the assumption of its liabilities. Nevertheless, the people in their desperation were reported as trying to issue and sell bonds, secured by their property, in order to give to the California Development Co. $1,000,000 to assist in repairing the break.

The complications which have arisen from the transfer of the property and the involved relations of the California Development Co. with its numerous subsidiary companies are such that the United States would not be justified in having any dealings with this company until the complications are removed and the government has a full understanding of every phase of the situation.

It has been stated above that the California Development Co. has not the financial strength to repair the break and to restore the bank of the Colorado River to such permanent conditions that a similar occurrence cannot happen. It is further understood that the Southern Pacific Co., having expended $2,000,000 or more for the protection of its interests, declines to furnish more money to the California Development Co. to save the Imperial Valley, beyond control from the present break in the river bank. The owners of the property in Imperial Valley, both farmers and townspeople, together with the Southern Pacific Co. and the California Development Co., have combined to call upon the government for a contribution to assist the California Development Co. to the extent of erecting permanent works to insure protection for the future.

If the river is not put back and permanently maintained in its natural bed, the progressive back cutting in the course of one or two years will extend upstream to Yuma, as before stated, and finally to the Laguna dam, now being built by the government, thus wiping out millions of dollars of property belonging to the government and to citizens. Continuing further it will deprive all the valley lands along the Colorado River of the possibility of obtaining necessary supply of water by gravity canals.

The great Yuma bridge will go out and approximately 700,000 acres of land as fertile as the Nile Valley will be left in a desert condition. What this means may be understood when we remember that the entire producing

area of Southern California is about 250,000 acres. A most conservative estimate after full development must place the gross product from this land at not less than $100 an acre a year, every ten acres of which will support a family when under intense cultivation. If the break in the Colorado is not permanently controlled the financial loss to the United States will be great. The entire irrigable area which will be either submerged or deprived of water in the Imperial Valley and along the Colorado River is capable of adding to the permanent population of Arizona and California at least 350,000 people, and probably 500,000.

Much of the land will be worth from $500 to $1,500 an acre to individual owners, or a total of from $350,000,000 to $700,000,000.

PROMPT ACTION NECESSARY.

The point to be especially emphasized is that prompt action must be taken, if any, otherwise the conditions may become so extreme as to be impracticable of remedy. The history of past attempts to close the break in the river bank has shown that each time, through delay, the work has cost double or treble what it would have cost had prompt action been taken. It is probable now that, with an expenditure of $2,000,000, the river can be restored to its former channel and held there indefinitely, but if this action is not taken immediately, several times this sum may be required to restore it, and possibly it cannot be restored unless enormous sums are expended.

At the present moment there appears to be only one agency equal to the task of controlling the river, namely, the Southern Pacific Co., with its transportation facilities, its equipment, and its control of the California Development Co. and subsidiary companies.

The need of railroad facilities and equipment and the internal complications are such that the officers of the United States, even with unlimited funds, could not carry on the work with the celerity required. It is only the fact that the officers of the Southern Pacific Co., acting also as officers of the California Development Co., have been able to apply all its resources for transportation, motive power and the operation of the road that has made it possible to control the situation to the extent to which they have already done. The Southern Pacific Co. is now reported to be working strenuously to fill the break through which the Colorado River is flowing westward to the Salton Sea and in repairing and building levees to keep out the high water due next March. This work will be more or less of a temporary character. Further construction is necessary, and all temporary works must be replaced by permanent structures. It is estimated that for this additional work $2,000,000 should be available. The question as to what sum, if any, should be paid to the Southern Pacific Co. for work done since the break of Nov. 4, 1906, is one for future consideration; for work done prior to that date no claim can be admitted.

But one practicable course is now open for consideration. The Southern Pacific Co. must continue its work to close the break and restore the river to its proper channel. The United States can then take charge, making the protective works permanent and providing for their maintenance.

THE PROPOSED PLAN OF ACTION.

It is not believed that a free gift of this money should be made, as by its investment the stability of property of great value will be secured and the increase in land values throughout the Imperial Valley will be sufficient to justify the provision that this money should be returned to the government.

The reclamation service should be authorized to take steps at once for the construction of an irrigation project, under the terms of the Reclamation act, for the lands in the Imperial Valley and in the lower Colorado River Valley. The service should be in position to proceed actively with the organization of the project and the construction of the works as soon as the conditions in regard to the protection of the valley against overflow will justify expenditures for this purpose.

To accomplish this, the United States should acquire the rights of the California Development Co. and its subsidiary corporations in the United States and Mexico upon such reasonable terms as shall protect the interests of the government and of the water users.

The United States should obtain by convention with Mexico the right to carry water through that country upon reasonable conditions.

Most of the land in the Imperial Valley has been entered under the terms of the Desert Land act or the Homestead laws, and title has not passed out of the United States.

The construction work required would be: The main canal, some sixty miles in length, from Laguna Dam into the Imperial Valley; the repair and partial reconstruction of the present distribution system in the valley and its extension to other lands, mainly public; diversion dams and distribution systems in the Colorado River Valley, and provision for supplementing the natural flow of the river by means of such storage reservoirs as may be necessary. This would provide for the complete irrigation of 300,000 acres in the Imperial Valley and for 400,000 acres additional in the United States in the Valley of the Colorado in Arizona and California.

AN APPROPRIATION ASKED FROM CONGRESS.

The reclamation fund now available has been allotted for projects under consideration, and the anticipated additions to the fund for the next few years will be needed to complete these projects. It will, therefore, be impossible to construct a reclamation project for the Imperial Valley with the funds now in hand, and it will be necessary for Congress to make specific appropriation for this work if it desires to undertake it.

Such appropriation would be expended for a project carried out under all the provisions of the reclamation act, requiring the return to the reclamation fund of the cost of construction and maintenance of the irrigation works, and there should be the further requirement that the cost of permanent protective works and their maintenance be repaid.

The interests of the government in this matter are so great in the protection of its own property, particularly of the public lands, that Congress is justified in taking prompt and effective measures toward the relief of the present situation. No steps, however, should be taken except with a broad comprehension of the magnitude of the work and with the belief that within the next ten years, the works and development will be carried out to their full proportions.

The plan in general is to enter upon a broad, comprehensive scheme of development for all the irrigable land upon the Colorado River, with the needed storage at the headwaters, so that none of the water of this great river which can be put to beneficial use will be allowed to go to waste. The Imperial Valley will never have a safe and adequate supply of water until the main canal extends from the Laguna dam. At each end this dam is connected with rock bluffs and provides a permanent heading founded on rock for the diversion of the water. Any works built below this point would not be safe from destruction by floods, and cannot be depended upon for a permanent and reliable supply of water to the valley.

If Congress does not give authority and make adequate provision to take up this work in the way suggested, it must be inferred that it acquiesces in the abandonment of the work at Laguna and of all future attempts to utilize the valuable public domain in this part of the country.

Theodore Roosevelt.

Jan. 12, 1907.

THE BIDS FOR THE CONSTRUCTION OF THE PANAMA CANAL.

Bids for the completion of the Panama Canal on a percentage basis were opened at the office of the Isthmian Canal Commission in Washington on Jan. 12. The specifications and contract on which the bids were invited were printed in full in our issues of Oct. 18, Nov. 8, and Dec. 20. As our readers will recall, the contractor is to act practically as an agent for the Government, which pays the entire cost of the work, including that of the contractor's organization, and furnishes the working plant and all materials. The work is to be done, of course, under the direction of the Chief Engineer and on the general plan of construction approved by Congress at its last session. The contractor is to receive as his compensation the percentage on the cost which he bids plus a bonus for reducing the cost of the work and the time of construction below the official estimates or minus a penalty for excess of cost or excess of time. The following is an official summary of the bids opened on Jan. 12:

Bid No. 1, of George Peirce & Co., of Frankfort, Maine, and New York City, a partnership composed of George Peirce and Earl S. Peirce. Bid amounted to 7.19% upon the estimated cost of construction, to be fixed as provided in contract.

Bid No. 2, of William J. Oliver, of Knoxville, Tenn., and Anson M. Bangs, of No. 5 Nassau St., New York City. Bid amounted to 6.75% upon the estimated cost of the construction, to be fixed as provided in contract.

The statement furnished by these bidders shows that the assets of William J. Oliver exceed his liabilities by over $3,000,000, and the assets of Anson M. Bangs exceed his liabilities by over $2,000,000. The bidders further state that William J. Oliver and Anson M. Bangs have credits and means of credits more than ample to finance all the contractors' expenses and outlays, details of which will be furnished the Commission if desired. This bid was accompanied by a certified check on the Commercial National Bank of Washington, D. C., in the sum of $200,000.

William J. Oliver has been in the contracting business for 24 years, and during the past 10 years has completed, among other substantial contracts, the following: Construction of Ensley Southern R. R. in Alabama, 32 miles heavy rock work, $1,800,000. Reconstruction of 125 miles of the Western North Carolina Ry., $2,500,000. Double-tracking Virginia Midland Ry., 55 miles, $[illegible]-000. Constructing 80 miles of Tidewater R. R., $1,[illegible]. Constructing 100 miles Tennessee Central R. R., $2,[illegible]. Grade reduction of 60 miles, Louisville & Nashville [illegible], $1,250,000. The total work completed by this contractor in the past ten years has amounted to $18,000,000.

This bidder has now in progress the following: Double-tracking Knoxville & Morristown R. R., 42 miles, $[illegible]-000. Construction of Little Tennessee R. R., 75 miles, $3,500,000. Construction of Memphis & Chattanooga R. R., $3,500,000. Double-tracking Cincinnati Southern R. R., 60 miles, $4,000,000. Double-tracking 44 miles for Southern Ry., south of Lynchburg, $4,500,000. Constructing 102 miles New Orleans Great Northern Ry., $3,000,000. Total work in progress approximating the sum of $31,500,000.

Upon the work now in progress William J. Oliver has the following equipment: 48 steam shovels, 120 locomotives, about 118 dump cars, 3 1,900-ft. cableways, 3 air compressors, 2 suction dredges, 2 orange-peel dredges, about 250 drills, about 2,400 mules; also derricks, locomotive cranes, carts and wagons, and other tools sufficient to carry on expeditiously all the work in progress mentioned above.

A schedule of past experience is also submitted by Anson M. Bangs, who has completed during the past ten years substantial contracts for the United States Government as follows: Ship lock at Sault Ste. Marie, Mich., known as the Poe Lock, amounting to $2,500,000. Delaware Breakwater, 1,500,000 tons of deposit within contract time, amounting to $2,500,000. Buffalo Breakwater, 1,250,000 tons deposit within contract time, amounting to $2,500,000.

Bid No. 3, MacArthur-Gillespie Co.—President, A. F. MacArthur, Fisher Building, Chicago, Illinois. Amount bid 12½% upon the estimated cost of construction as provided in contract. The MacArthur-Gillespie Co. is a corporation incorporated under the laws of the State of New Jersey, having a capital stock of $5,000,000, all subscribed for. Officers are: President, A. F. MacArthur; Vice-President, T. A. Gillespie, Westinghouse Building, Pittsburg, Pa.; Secretary and Treasurer, Frederick H. Reed, 42 Exchange Place, New York City. The MacArthur-Gillespie Co. has entered into contracts with MacArthur Brothers, T. A. Gillespie Co., Atlantic, Gulf & Pacific Co., and J. G. White Co., which companies will place at the disposal of the bidder, if awarded the contract for completing the construction of the canal, their organization and facilities. The MacArthur Brothers Co. is carrying on a contracting business founded by John R. MacArthur in 1826. During the past year the company has employed, approximately, an average of 12,000 men and has over 40 steam shovels in operation. It has a full contracting organization, including a full organization of engineers, superintendents and foremen. This company has successfully carried through a large number of important contracts, among others being the following: The Wachusett Dam, in Massachusetts, the largest artificial reservoir in the United States; the first water power canal at Sault Ste. Marie, Mich.; twenty masonry locks and large dams for the United States Government, and the States of New York and Illinois; four sections of the Chicago drainage canal; the entire work of preparing the World's Fair Grounds at Chicago in 1892; several thousand miles of heavy railroad construction, including portions of many principal trunk lines in the U. S.

The T. A. Gillespie Co. employs on an average between 4,000 and 5,000 men a year; has a full force of engineers, superintendents and foremen. Among other important constructions it has executed several reservoir dams for the East Jersey Water Co.; the power-house for the St. Lawrence Power Co. at Massena, N. Y.; five dams and locks for the United States Government on the Monongahela and Ohio Rivers; reservoirs for the cities of Pittsburg, Allegheny, Minneapolis, Erie, Troy, Atlanta and New York; the Pittsburg filtration plant, now in progress, and a large amount of railroad, pipe and tunnel work.

The Atlantic, Gulf & Pacific Co.—This company has been in existence for about 30 years. Its specialty is dredging, and in hydraulic dredging it claims to be the largest operator in the United States. It has 17 complete dredging plants, having an average capacity of 30,000,000 cu. yds. of material. It has a staff of 50 skilled and experienced dredging superintendents and engineers. It has successfully carried out, among other work, the following: Harbor improvements in Manila for the Insular Government; over 50 contracts for the War Department of the United States; several canals, including one seven miles long at Sabine, Texas; one five miles long connecting the Yazoo with the Mississippi; one between Oakland and the Leandro River in California; the waterway in the Lake Washington Canal at Seattle, and a section 20 miles long connected with the building of the New York Barge Canal between Lake Champlain and the Hudson River.

J. G. White & Co., which company is also associated with this bidder, is in the contracting business, established a number of years ago, and has in hand about $26,000,000 of engineering and construction work. It has a full staff of engineers, superintendents and fore-

...tion. Among other work accomplished by this company ... harbor improvements at Cebu and Iloilo, Philippine Islands; United States Coaling Station at Olongapo; a number of steam and electric roads, and a number of railroad and lighting installations and hydraulic plants.

Bidder No. 4, the North American Dredging Co.—This company is a corporation, with officers as follows: William H. Allen, President, Los Angeles, Cal.; R. A. Perry, Vice-President and General Manager, San Francisco, Cal., and William Mead, Secretary and Treasurer, Los Angeles, Cal. This bid was accompanied by bond with the Metropolitan Surety Co., of New York, as surety, in the sum of $200,000. The amount of this company's bid was 28% upon the estimated cost of construction fixed in the contract. This company owns nine large dredges, several of which are of the hydraulic type, two of which are self-propelling. They state that this entire plant can be made available within 90 days upon the Isthmus, if the Government so desires. By making use of this plant of dredges, the bidders state that work could be immediately commenced on the Atlantic and Pacific terminals of the canal. The above dredging plant is located part on the Pacific side and part of it on the Atlantic side of the Isthmus. The past experience of this company, they state, is as follows: During the year 1905-6 and within ten months from commencement they dredged the harbor of Honolulu and bar, with one of their sea-going dredges, earning about $4,000,000. During the years 1903 and 1904 many miles of the St. Johns River, Florida, was dredged by this company, for the War Department. During the year 1904 the harbor at Tacoma, Wash., was dredged by this company, some 2,000,000 cu. yds. of material being removed. In 1903-1904 they dredged the San Pablo Bay, California, and the dredged material was delivered some ten miles away. The bar and harbor of Wellington has been dredged by this company, and many other large contracts have been executed for the War Department, all of which are of record. The general manager of this company has twenty years' experience in all kinds of work connected with harbor improvements, steam shovels and concrete work.

Besides the above official summary of the record of work accomplished by the Oliver-Bangs combination, the lowest bidders, the following is added from the statement submitted with their bid.

Mr. Wm. J. Oliver has built (in addition to the railway work mentioned above, and several additional lines not there included) the Church St. concrete viaduct at Knoxville, costing $150,000, and the terminals for the Union Station at Savannah, Ga., costing $200,000. He has now under contract besides the work covered in the official summary, the Washington St. concrete viaduct in Atlanta, Ga., costing $150,000, and ten reinforced concrete buildings, from two stories to ten stories in height, located in various Southern cities, and involving a total expenditure of about $2,000,000. The statement continues as follows:

In connection with the large amount of plant listed above, Wm. J. Oliver maintains a large manufacturing plant and machine shop at Knoxville, Tenn., for the repair and maintenance of this outfit, and for the manufacture of his own dump and coal mine cars and spreaders, the plant costing $700,000.

Mr. Oliver also owns a number of coal mines from which are supplied contracts in his immediate vicinity with their supply of coal.

It is worthy of note that much of the experience which Mr. Oliver has had has been under semi-tropical conditions with negro labor, where he has encountered both yellow fever and small-pox in his camps and successfully combated both. His work in the vicinity of New Orleans during the last yellow fever epidemic was not stopped and in fact was impeded but little by the prevalence of this disease.

In connection with his work, Mr. Oliver employs about 25,000 men with the necessary mechanics, engineers, steam shovel men, foremen, superintendents and managers.

It is his practice to give the manager of each job an interest in the profits of that job, and he has about 25 such managers. He can safely assert that 95% of his managers, superintendents, foremen, engineers, steam shovel men and mechanics will be glad to enter upon the work of the construction of the Panama Canal under his supervision. It is also safe to say that from his present force, he can send to Panama, managers, superintendents, foremen, mechanics, engineers and steam shovel men adequate to handle the Panama contract and fill their places on his work in the United States with other competent men now in his employ.

Mr. Anson M. Bangs, besides the work summarized in the statement above, was also the builder of the Point Judith breakwater, where 1,000,000 tons of stone were deposited within contract time, and of many other smaller works of similar character involving a total cost of about $2,000,000. He is now building a breakwater at Cleveland which will cost $2,500,000, and one at Cape Ann costing $300,000, as well as breakwaters at Ashtabula and Fairport, on Lake Erie.

A CHESAPEAKE-DELAWARE SHIP CANAL has been reported on by a government commission appointed last year on authorization of Congress. There is now in existence a barge canal connecting Chesapeake Bay and the lower Delaware River, owned and operated by a private company. The commission considered this route and half a dozen others as routes for a ship canal, and recommended the location of the present canal as the best route. On the general question of the advisability of constructing the ship canal, a strongly favorable report is rendered. The commission consisted of Gen. F. Agnus, Major C. A. F. Flagler, and Mr. F. T. Chambers, of the Engineer Corps of the Navy. The report recommends a channel 35 ft. deep and 150 ft. in minimum width. The cost of such a canal is estimated at $20,621,000, or for a 30-ft. depth $17,312,000. It is recommended that the sum of $2,514,289.70 be paid for the present canal property. A canal over the Sassafras River route, the most prominent competitor of the present or Back Creek route, would cost at least half a million more than the recommended canal.

THE SCRANTON TYPHOID EPIDEMIC numbered 1,006 cases and 86 deaths, so far as reported up to noon of Tuesday, Jan. 15. For the past week the number of cases has been, by days, 16, 9, 8, 8, 7, 7 and 8, the latter on Jan. 15. The State Department of Health continues in sanitary control of the drainage area of the Scranton Gas & Water Co., and, judging from a somewhat indefinite official statement, is dosing the water with copper sulphate. The water company has instituted proceedings to secure an injunction to restrain the Delaware, Lackawanna & Western Railroad Co. from taking certain of the lands of the former for a new track location, which new location would give the railroad tracks on each side of Roaring Brook. The water company claims that the proposed new railway line would damage its water supply.

LIMITATION OF THE HOURS OF WORK of railway operatives is proposed by a bill drafted by Senator Lafollette of Wisconsin, and passed by the Senate last week by a vote of 70 to 1. As passed, the bill forbids continuous service on the part of railroad employees actually connected with train movements for more than sixteen consecutive hours at a time, and provides for ten hours' rest in the case of any employee who has been on duty for the maximum number of hours. An amendment excepts from the restriction employees delayed by accidents and thus prevented from reaching home or making the scheduled connection with other trains.

As bearing on the need of legislation of some sort in this direction, or at least of some measure for prodding railway officers to a realization of their responsibilities for safe railway operation, some of the testimony before the Interstate Commerce Commission in its investigation of the Terra Cotta disaster is of interest. According to press reports of the testimony, given on Jan. 14, Mr. T. Fitzgerald, General Manager of the Baltimore & Ohio system, testified that accidents largely occur as the result of the failure of men to take the proper time to rest.

J. W. Kelly, Jr., Trainmaster of the B. & O. at Baltimore, was questioned in regard to the hours of employment of men engaged in the handling of trains, and admitted that local train crews worked during October and November last on an average of 16 hours daily for six days a week, without a period of rest. In cases trainmen worked 36 hours without relief, while others worked five and six days at a time on an average of 20 hours a day.

A BROKEN WHEEL on an express car wrecked the "Transcontinental Express" of the Canadian Pacific Ry. at Kaministiquia, Northwest Ontario, Jan. 7. Five coaches and the mail car were ditched, but the dining car and sleepers remained on the rails. Two men were killed and six others injured.

AN OPEN SWITCH wrecked an east bound passenger train on the Chicago, Rock Island & Pacific Ry. at Barney, N. Mex., Jan. 13. The locomotive, the express car, the dining car and a Pullman were ditched and five persons killed and eight injured.

A TIDAL WAVE devastated the Dutch East Indian islands Tana and Simalu Jan. 10, and killed some 350 people, according to press reports. These islands are situated off the coast of Sumatra and form part of the Dutch possession in the Malay Archipelago.

AN EXPLOSION OF GAS in one of the Eliza blast furnaces of the Jones & Laughlins Co., Ltd., Pittsburg, Pa., Jan. 9, wrecked the furnace, killed 12 men and injured 10 others, four fatally, while from 15 to 20 others are missing, and it is supposed that they were cremated. The accident occurred shortly before 7 o'clock in the evening, the night shift, composed of about 40 men, having gone to work but a short time before. Preparations were being made to tap the furnace, which contained about 100 tons of molten iron, when the explosion took place. The front of the furnace was blown out and the steel plates forced apart, while the molten metal was showered over the workmen. It is stated that the furnace had been giving trouble by hanging and irregular working for some days previous to the explosion.

AN EARTHQUAKE partly destroyed the city of Kingston, capital of the Island of Jamaica, Jan. 14. The shock occurred at about 3 p. m., without warning, and wrecked many of the principal buildings of the city. The loss of life is variously placed by press dispatches at from 30 to 100, while several hundred are said to have been injured. Nearly all the casualties were among the native blacks. The wreckage along the docks and in the warehouse district immediately took fire, and, according to last reports, was still burning. The British Military Station and Hospital are said to have been destroyed, as well as the Myrtle Bank Hotel, the principal hostelry of the city.

STREAM GAGING IN ALASKA was carried on by the U. S. Geological Survey all of last summer, and the report on the water resources of the Nome region is about to be published by the Survey. It is becoming more and more evident that the chief problem of the Nome placer miner is how to obtain an adequate supply of water. When the gold fields were first opened the mineral was so abundant and the facilities for working so poor that no well-ordered plan of mining was carried on. Now that the country is more accessible and the ore less widely distributed the necessity for economic mining is recognized and this work of the Survey is one of the first steps in this direction.

PERSONALS.

Mr. William H. Lawton, M. Am. Soc. C. E., has been elected City Engineer of Newport, R. I.

Mr. J. N. Ambler has been elected City Engineer and Superintendent of Water-Works of Winston, N. C.

Mr. Frederick C. Stevens, of Attica, N. Y., has been appointed by Governor Hughes, Superintendent of Public Works. He has previously held other public offices.

Mr. Robert Blickensderfer, Consulting Engineer for the Wheeling & Lake Erie R. R., and formerly General Manager, has resigned and will retire to his farm in Missouri.

Mr. Charles Hausel, M. Am. Sos. C. E., has opened an office as Consulting Engineer at 43 Wall St., New York City, and will make a specialty of the investigation of new enterprises for investors and others.

Mr. J. A. Wilson has been appointed Division Superintendent of the Houston, San Antonio, Waco & Austin Division of the Missouri, Kansas & Texas Ry., to succeed Mr. J. H. Davisson, resigned. His headquarters are at Smithville, Tex.

Mr. T. W. Robins has been appointed General Superintendent of the Southern District of the Rock Island Lines, with office at Fort Worth, Tex. Mr. Matthew McKiernan has been appointed Division Superintendent at Fort Worth.

Mr. J. C. Nelson, who was recently appointed Assistant Chief Engineer of the Queen & Crescent Route, has resigned, before assuming the office, to become Chief Engineer of the Seaboard Air Line Ry., in charge of maintenance of way.

Mr. Albert H. Dakin, Jr., Engineer in Charge of Construction of the New York City Terminal of the Central Railroad of New Jersey, has resigned to become Terminal Engineer of the Lehigh Valley R. R., with headquarters at 143 Liberty St., New York City.

Mr. Chas. E. Bright, Assoc. M Am Soc. C. E., Resident Engineer of the Tidewater R. R., has resigned to become Assistant Engineer on the surveys of new lines for the Nashville, Chattanooga & St. Louis Ry. His headquarters are at Room 10, Union Station, Nashville, Tenn.

Mr. Walter B. Pollock, Manager of the Foreign Freight and Marine Department of the New York Central & Hudson River R. R., has been appointed General Manager of the Merchants' Dispatch Transportation Co., to succeed the late Arthur Mills. He will now represent both companies.

Mr. Joseph Wood has been advanced from Second Vice-President of the Pennsylvania Lines West of Pittsburg to First Vice-President; Mr. J. J. Turner from Third to Second Vice-President; Mr. Edward B. Taylor

from Fourth to Third Vice-President, and Mr. Daniel T. McCabe from Freight Traffic Manager to Fourth Vice-President.

Mr. Frederick G. Myhlertz, a building inspector of New York City, has been appointed Engineer of Construction. This office has just been created, and Mr. Myhlertz will have general supervision of all building going on in the city. He is a graduate of the University of Pennsylvania, and has been an inspector since 1894. The salary of the new position is $2,500.

Mr. Wm. Paul Gerhard, Consulting Sanitary Engineer, 32 Union Square, W., New York City, will sail for Europe on the "Kronprinz Wilhelm" on Jan. 22. He visits his old home after an absence of thirty years. During his stay abroad he will study sewage purification works, city markets and abattoirs, public baths and city improvements. Among the cities he will visit are Bremen, Hamburg, Kiel, Berlin, Leipzig, Dresden, Nuernberg, Munich, Stuttgart, Heidelberg, Karlsruhe, Freiburg, Strassburg, Paris, London and Amsterdam. He will return to the United States in May.

Mr. Frank P. Allen, Jr., Manager of the General Engineering & Construction Co. of Seattle and Portland, has been appointed Director of Works of the Alaska-Yukon-Pacific Exposition, which is to be held at Seattle during the summer of 1909. He will have charge of all work done on the grounds and after the exposition opens, charge of maintenance of grounds and buildings. Mr. Allen had charge of the structural work of the Lewis and Clark Exposition. He is a graduate of the University of Michigan in the civil engineering course and has had considerable experience in building bridges, railroads and large steel-framed buildings.

Mr. W. V. Alford, Chief Engineer of the Kansas Natural Gas Co., has resigned and gone to Peru, S. A., as Division Engineer of the Cerro de Pasco R. R. Mr. Alford is one of the old isthmian canal engineers. He was first employed on the old Menocal Canal Survey in Nicaragua during 1887-1888. He was Chief of Party on the Darien Survey, and made the survey along the Continental Divide from Darien to Panama. On the completion of this work he was transferred to Nicaragua. He remained with the Canal Commission until 1901, when upon the completion of the field work, he became Chief Engineer of the Kansas Natural Gas Co.

Mr. R. O. Wynne-Roberts, M. Inst. C. E., Water Engineer of Cape Town, South Africa, will return to England in April, since the Water-Works Department has been combined with that of City Engineer, and the office of Water Engineer abolished. Besides being a member of several of the more prominent European engineering societies, Mr. Wynne-Roberts is a member of the American Water-Works Association and the New England Water-Works Association. Upon his arrival in England he will open an office as a consulting engineer, giving attention to gas and water supply, sewerage and sewage disposal, and other public improvements. His temporary address is care Alderman W. H. Williams, J. P., 3 Cable St., Liverpool.

Mr. H. J. Lamborn, Mechanical and Electrical Engineer and Superintendent of the Magnetic Separating Plants of Witherbee, Sherman & Co., Mineville, N. Y., has been appointed Superintendent of Power and Plant for the Yale & Towne Mfg. Co., New York City, to succeed Mr. F. A. Waldron, who resigned about a year ago. Mr. Lamborn will have general supervision of everything relating to steam and electric power and distribution, heating and ventilating, water supply, drainage, fire protection, etc. He is a graduate of the Towne Scientific School of the University of Pennsylvania and has at various times been associated with Mr. John C. Trautwine, Jr., the Engineering Department of the U. S. Army, the Hayatt Roller Bearing Co., and for the last four years with Witherbee, Sherman & Co. Mr. S. E. Dauchy, who has been Acting Superintendent, will assume his former position of Assistant Superintendent.

Obituary.

Alfred E. Davis, a pioneer railroad builder of California, died at San Francisco Jan. 6, aged 79 years.

Samuel Irving Thursby, the inventor of the hydraulic elevator, died at his home in Brooklyn, N. Y., Jan. 9, of pneumonia, aged 78 years. He was born at Brooklyn, Mar. 18, 1828, and had always lived there. He retired from the elevator business about 20 years ago.

Captain Thomas W. Dodd, Vice-President of the Texas Mexican Ry., died at Laredo, Tex., Jan. 13, aged 62 years. He was born in Baron County, Ga., May 23, 1840, and graduated from the University of Georgia in 1868. He entered railway service in 1884 as an attorney and land agent, and was elected Vice-President of the Texas Mexican Ry. and General Attorney for the National R. R. of Mexico in 1888.

Burdette C. Gowing, Chief Engineer U. S. Navy (retired), died Jan. 12 at Tully, N. Y., aged 68 years. He was born at Tully and was a graduate of Rensselaer Polytechnic Institute of Troy. He entered the naval service in October, 1861, as a third assistant engineer, and was commissioned a first assistant engineer in 1866. He was made chief engineer on Feb. 15, 1886, and retired Jan. 28, 1895, for physical disability.

James Clayton, a retired manufacturer of steam and air pumps, and a well-known inventor, died at his home in Brooklyn, N. Y., Dec. 31, aged 84 years. He was born at Homer, England, and came to this country in 1849, locating in Nevada, where he was successful in gold mining. In 1864 he began the manufacture of pumps at Brooklyn, N. Y. He was the inventor of several kinds of pumps and other apparatus, his best known invention being an air compressor, which bears his name. He retired from business five years ago.

H. Wilson Harding, Emeritus Professor of Physics at Lehigh University, died at Philadelphia, Pa., Dec. 12. Professor Harding was a graduate of Washington College, class of 1854, receiving the A. B. degree. Later the degree of A. M. was conferred upon him by Bethany College. In 1872 he was appointed Professor of Physics and Mechanics at Lehigh, which chair he held until 1883, when he relinquished charge of Mechanics. He was appointed Professor of Physics and Electrical Engineering in 1891, a four-years' course in electrical engineering having prior to this time been established under his direction. The building known as the Physical Laboratory was projected and planned by him, and completed in 1893. He was retired from active duty in 1897 and made Emeritus Professor. For several years past Professor Harding had resided near Seattle, Wash.

John Linzie Snelling, formerly Assistant Superintendent of the Boston & Albany Division of the New York Central & Hudson River R. R., died at his home in Newton, Mass., Jan. 11, of kidney trouble, aged 43 years. He was born at Boston, Mass., Jan. 3, 1864, and graduated from Harvard with honors in 1887. After serving in the freight departments of the New York & New England R. R., the New York, New Haven & Hartford R. R., and the New York Central & Hudson River R. R., he was made, in 1897, Superintendent of the Worcester Division of the New York, New Haven & Hartford R. R. Later he became Assistant Superintendent of the Boston & Albany Division of the New York Central lines. In 1904 he was appointed by President Roosevelt, Appraiser of the Boston Custom House. He resigned this position a few months ago on account of poor health.

ENGINEERING SOCIETIES.

COMING MEETINGS.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Jan. 16-17. Annual Meeting at New York City. Secy., C. W. Hunt, 220 West 57th St., New York.

NORTHWESTERN CEMENT PRODUCTS ASSOCIATION.
Jan. 16-18. Annual Convention at St. Paul, Minn. Secy., Martin T. Roche, 410 Pioneer Press Bldg., St. Paul, Minn.

INDIANA ENGINEERING SOCIETY.
Jan. 17-19. Annual Meeting at Indianapolis. Secy., C. C. Brown, Commercial Club Bldg., Indianapolis, Ind.

THE ENGINEERS' CLUB OF PHILADELPHIA.
Jan. 19. Annual Meeting at Philadelphia. Secy., Walter Loring Webb, 1122 Girard St., Philadelphia, Pa.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
Jan. 22-24. Annual Meeting at New York City. Secy., W. M. Mackay, P. O. Box 1818, New York City.

OHIO ENGINEERING SOCIETY.
Jan. 22-24. Annual Convention at Columbus, Ohio. Secy., E. G. Bradbury, 85 North High St., Columbus, Ohio.

ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS.
Jan. 23-25. Annual Meeting at Peoria, Ill. Secy., E. R. Tratman, 1636 Monadnock Block, Chicago, Ill.

CANADIAN SOCIETY OF CIVIL ENGINEERS.
Jan. 29. Annual Meeting at Montreal. Secy., Prof. C. H. McLeod, 877 Dorchester St., Montreal, Quebec.

THE NATIONAL BRICK MANUFACTURERS' ASSOCIATION.
Feb. 4-16. National Convention at St. Louis, Mo. Secy., Theo. A. Randall, Indianapolis, Ind.

NEW ENGLAND GAS ASSOCIATION.
Feb. 21. Annual Meeting at Boston, Mass. Secy., N. W. Gifford, East Boston, Mass.

ASSOCIATION OF ONTARIO LAND SURVEYORS.
Feb. 26. Annual Meeting at Toronto. Secy., Killaly Gamble, 405 Temple Bldg., Toronto, Ont.

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION.
Mar. 19-21. Annual Meeting at Chicago, Ill. Secy., L. C. Fritch, 1562 Monadnock Block, Chicago, Ill.

WESTERN SOCIETY OF ENGINEERS.—The annual meeting and dinner were held on Jan. 8 at Chicago. The report of the secretary showed a membership of 925, a net gain of 69 for 1906. The members are classed as follows: Honorary member, 1; active members, 725; associate members, 73; juniors, 126; total, 925. During the year 36 members were lost, 30 by resigning or being dropped, and 6 by death (H. W. Parkhurst, John Saltar, Jr., A. W. Fiero, F. P. Dobson, A. V. Abbott and O. B. Green). The report of the library committee gave the total number of books as 6,103, an increase of 506 over the previous year; the total net charge against the library was $793, of which $300 was for preparing a list of the books. This will be printed shortly. During the year 29 meetings were held, at which 31 papers or addresses were presented.

The officers elected for the year 1907 are as follows: President, W. L. Abbott; Vice-Presidents, Andrews Allen, E. N. Layfield and A. N. Talbot; Treasurer, A. Reichmann. The Secretary is J. H. Warder.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—The January meeting at New York City, on the evening of Tuesday, Jan. 8, was of special interest because it was the first public meeting held in the new Engineering Building, on West 39th St. A very large gathering graced the occasion, in spite of rather unfavorable weather; the large main auditorium, in which the meeting was held, was filled to its seating capacity of 1,000 persons. Mr. Frederick P. Fish, President of the American Bell Telephone & Telegraph Co., New York, delivered an address on the subject, "The Ethics of Trade Secrets, in Relation to the Patent System." The speaker explained in detail the common-law principles which have become established by a series of English and American court decisions on the matter of "trade secrets." The basal principle is that a trade secret, knowledge of which is acquired in a confidential relationship, or otherwise under circumstances which might argue an implied contract to keep the secret, may not be divulged; injunctions may be issued by the court to prevent publication or use of the secret so acquired. But any one is at liberty to learn another's trade secret by stealth or surreptitiously, and may not be prevented from using it. Mr. Fish also argued at considerable length on the excellence of this view of trade secrets, and asserted that it was clearly favorable to the proper development of industry. He holds that the existence of the patent system does not have the effect of superseding the need of protection for trade secrets, although he concedes that it might do so if the patent statute were perfect and its administration ideal.

AMERICAN SOCIETY OF INSPECTORS OF PLUMBING AND SANITARY ENGINEERS.—The second annual meeting of this society was held at Cleveland, Ohio, on Jan. 8, 9 and 10, with Mr. Henry B. Davis, of Washington, President of the society, in the chair. The opening address was made by Dr. Martin Friedrich, Health Officer of Cleveland. In the course of his remarks Dr. Friedrich commended the plumbing code prepared for Cleveland by Mr. John Eisenmann and now before the Council of that city. He also laid great emphasis upon the necessity of rigid control of plumbers' work through inspection, and by inference the need for licensing plumbers.

The president, in the course of his annual address, stated that the membership had increased during the year from 21 to 91. He expressed a hope that chapters of the society would be formed in the various states and cities of the Union, and also in Cuba and Canada. State organizations, similar in character, already exist in Illinois and Massachusetts. A postal-card canvass to ascertain the number of cities of 5,000 population and over having an inspector of plumbing, sewer and water connections, resulted in 585 replies out of 1,000 inquiries, showing plumbing inspectors in 297 cities, 14 of which are Canadian; also that health officers had charge of plumbing in 11 cities, one of which is Canadian; city engineers in 24 cities, 6 of which are Canadian, and that in 21 cities the water-works superintendent and in 8 cities the sewer superintendent had charge of this work. The remaining 224 cities replying to the inquiry stated that there was no inspector of plumbing. Indiana made a particularly bad showing in this respect, there being no inspector in 31 of the 38 cities in the state, including Indianapolis with a population of 240,000, Ft. Wayne, Evansville and Muncie with populations of 60,000 to 80,000, and Marion with a population of 30,000. So large a city as New Orleans is without a plumbing inspector, and the capital of Pennsylvania (Harrisburg, 75,000 population in 1900) has neither plumbing code nor plumbing inspector. Harrisburg, it appears, is in the third class of Pennsylvania cities, none of which are required by law to have a plumbing code or inspector. President Davis laid stress upon the desirability of a longer term of office than one or two years for plumbing inspectors, and of putting the position under civil service rules. He also advocated a "permanent municipal museum of plumbing."

Papers were read by Mr. Charles B. Ball, M. Am. Soc. C. E., of Chicago, on "The Relation of Inspectors of Plumbing to Other City Officials"; H. J. Luff, of Cleveland, on "Non-Siphon Traps"; Francis H. Wright, of Helena, Ark., on "Plumbing Engineering"; M. M. O'Connell, Inspector of Plumbing, Ottawa, Ont., on "Why the Use of the Intercepting Trap Should Be Made Compulsory in All Plumbing Systems"; Burton J. Ashley, of Chicago, on "Sewage Disposal Without Sewers"; and there were also a number of other papers of a more general character. Reference to some of the papers named will be made in a later issue.

Chicago was chosen as the place for the next meeting. Mr. Henry B. Davis, Chief Plumbing Inspector of Washington, D. C., was re-elected as President, and Mr. Garrett W. Cotter, of New York City, was elected Secretary and Treasurer. Resolutions were adopted appreciative of the work of Mr. John Eisenmann, Code Commissioner of Cleveland, and condemnatory of the use of latrines "as usually installed and maintained" in public schools, factories, railway stations, etc.

ENGINEERING LITERATURE

Supplement to ENGINEERING NEWS. New York, January 17, 1907.

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EDITORIAL.

The large number of books and other publications reviewed in this issue of the Supplement, as well as the many prominent engineers who have cooperated with the editors in passing judgment upon them, is a promising sign for the future of engineering literature. That the names of so many notable books and well known engineers as authors and reviewers of them should appear in a single number is not owing to an undue accumulation of unnoticed volumes or to any unusual effort to make a showing of a large number of prominent contributors: it is all a part of the month's work, although naturally there are more new books at this than at some other times of year. Our readers need not worry about the immediate future, however, as a goodly number of books already await attention in our next issue.

We take pleasure in calling particular attention to the appearance of the fourth volume of "The Engineering Index," a review of which appears elsewhere in this issue. In this day of rapid technical progress the engineer who does not follow the course of events as recorded from week to week and month to month in the technical papers and in the proceedings of the engineering societies is lost. The number of these periodicals and the volume of their contents are so great, however, that no man can keep mental tab of the matter of value to him presented in even one journal, while to examine 250 current publications, in half a dozen languages, in search of the articles of specific value to him is a physical as well as a mental impossibility. All this work is done for the engineer, and on the whole remarkably well done, in the current index published in the monthly numbers of our contemporary, "The Engineering Magazine," and in the consolidated indexes, based on the monthly reviews, that are published from time to time.

We have good reason to know that a large percentage of the readers of this journal, and doubtless the same holds true of other technical papers, are or appear to be almost helpless when they find themselves in need of information beyond their range of experience or memory. They may have a dim idea that they "saw something somewhere" that would be of service to them, but where to turn to find it, especially with the assurance of finding *all* the valuable information available, they do not know. The "Index" under discussion affords an answer to all such questions. Moreover, it deserves financial support. The enormous labor and expense involved in its compilation and publication are so disproportionate to any possible direct financial returns from it as to put the "Index" almost in the same class as a public service dependent for its continuation upon public support. But buyers of the "Index" will be repaid ten to a hundred fold for their outlay in the rapid and complete reference which it can furnish on any point of difficulty or detail which may come before them. Its value as an indispensable tool to the engineer merits general appreciation.

CORRESPONDENCE.

Engineering Work in Towns and Small Cities.

Sir: In the Supplement of Dec. 13, 1906, a review appeared of my new book, "Engineering Work in Towns and Small Cities." I wish to call attention to three criticisms likely to give the reader of the review a false impression of the book.

The reviewer says that I say in effect that little is heard to-day of garbage reduction. This is true, but he overlooked the long paragraph qualifying my remark and especially the following two sentences:

Garbage contains more water and less grease in summer than it does in winter. It changes in composition from day to day, so a reduction plant must be located in a large place, where a certain amount of the right kind of garbage can be depended on.

Your reviewer in making his criticism forgot for a moment that my book is intended more especially for places containing under 20,000 inhabitants.

Your reviewer also says:

He also expresses himself [referring to the author] in questionably sweeping terms when he says that no town or city should accept a macadamized street.

What I do say in the book is:

It is a good material with which to start the improvement ball rolling, but no town or city should accept a macadamized street *to keep it in repair*.

The omission of the words here placed in italics alters the reading. In the next sentence I say:

A street should not be accepted until it is paved and macadam is not a pavement.

Many cities to-day are burdened with an immense annual expenditure for keeping macadamized streets in repair. Macadam was placed because the abutting owners wished to improve the street at the lowest possible first cost and saddle the enormous maintenance cost on the city at large.

This is not right. A state of practical bankruptcy faces many small municipalities because of such mistaken policy. Thousands of cities are issuing illegal certificates of indebtedness yearly for new work because the repairs to macadam roads eat up the road fund. The abutting owners whose parsimony led to the use of the macadam continually cry for repaving with something better. They do so because they figured from the start that if the city accepted their cheap street *to keep it in repair* that some day the repairs could be made to take the form of entire reconstruction with better material. Practical politicians can tell—if they would—how the word "repair" means patching with gravel on one block and reconstruction with better material on another. Many of your readers know cities where men have themselves elected to the council for the sole purpose of having streets in front of their property "repaired" (sic) at the public expense.

Another point. Exception was taken to a paragraph about the doom of macadam. Here is the paragraph in full, the words in italics having been omitted by your reviewer:

It is doomed, however, *and in its present form* will disappear, probably within the present generation, except in out of the way places.

The next sentence reads:

The reason for this is the rapid increase in the number of automobiles and the high speeds at which they usually run.

The four following pages then discuss and describe methods and materials used to make macadam roads stand up to the work demanded of them under modern conditions.

The automobile has been the cause of a revival of discussions on macadamized roads. I believe practice had become pretty settled on construction and repair of such roads. There has been lately a nauseating repetition and tiresome padding in good roads literature. Macadam engineers are now buzzing like swarming bees and park commissioners are in despair. The macadam road *in its present form* is doomed.

Yours truly,

Ernest McCullough.

P. O. Box 691, Chicago, Ill., Dec. 17, 1906.

[We reprint the concluding paragraph of our review, as follows:

Personal preferences and opinions are fully expressed. In so far as these are founded on experience, as is often the case, they are generally of value, but when the author says, in effect, that to-day little is heard of garbage reduction he conveys a wrong impression. He also expresses himself in questionably sweeping terms when he says no town or city should accept a macadamized street. This statement, in view of the large mileage of such streets being put down every year by municipalities themselves, both at home and abroad, needs more supporting evidence than the author gives to warrant its inclusion in a book designed largely for the uninformed city official. Possibly, although we doubt it, the author is right in saying that macadam will probably disappear within a generation, except in out-of-way places, but certainly its use will be justified for a few years to come in some parts of the country.

We leave to such of our readers as are interested the decision as to whether our comments give a false impression.—Ed.]

REVIEWS.

Railroad Location.

Reviewed by M. P. Paret,* M. Am. Soc. C. E.

RAILROAD LOCATION, SURVEYS AND ESTIMATES.—By F. Lavis, Assoc. M. Am. Soc. C. E., Resident Engineer, Pennsylvania Railroad Tunnels. New York: The Myron C. Clark Publishing Co. Cloth; 6 × 9½ ins.; pp. 270; 73 figures, mostly in the text, and 22 tables. $3.

In Chapter I., in giving the "Resumé of Methods and Explanation of Terms," the author states that one of the objects of a location survey, where a tentative rate of grade has already been established, is to determine what the lowest practical ruling grade will be. The reviewer holds that it is the preliminary survey which develops this feature, and not the location survey. Again, among the results to be obtained by location surveys, nothing can be found about economic maintenance or the development of a business giving maximum net revenue. The author recommends marking the stakes on a preliminary line (page 8) to hundreths. Why mark these stakes to hundreths, when, in actual practice, the chaining on preliminary lines is rarely, if ever, closer than tenths? On page 9, under "Hubs," no mention is made of desirability of placing hubs on preliminary location surveys, either near fences or at other points where such stakes are not apt to be disturbed. This with a view, at some later time, of more readily re-establishing the line on the ground. On page 12, the author states that profiles of preliminary lines will, as a rule, be used only as a basis for the topography. To the reviewer, it would seem that the author has a misconception of the value of a preliminary survey, particularly under the system of location advised by him. Certainly the preliminary survey not only practically determines, in considerable definiteness, the alinement, but further, the profile of the location survey determines the ruling grade and is the whole basis of the location profile. How can it be otherwise, if the final location is not to vary more than one or two hundred feet, one side or the other, from the preliminary line?

The author advocates a 5,000-ft. map, to enable the locater to obtain a correct idea of the general direction of his line and to study it as a whole. Many engineers prefer a map of this nature to be on a scale of 1-in. = 2,000 ft., particularly if there are maps, such as county maps, available on which the surveys could be platted. If the surveys be made in the United States, 2,000-ft. maps would be of service in the Chief Engineer's office, where maps of this scale are

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prepared for filing with the county and state authorities and also, frequently, for right-of-way purposes. The term "Soundings" (page 14) seems to be a misnomer. Webster's definitions of this word only cover the idea of determining the depth of water. It would look as if "Borings" or "Test pits" would apply better than the word "Soundings."

Chapter II., on "Reconnoissance," deals with the subject quite fully. However, the author should have brought out some other points, such as the importance of reconnoissance surveys being made both ways over the line. On page 16, the definition (in italics) of the location of the best line, seems again to deal only with first cost. It is not suggested that economic maintenance or economic operation, or net revenue has any bearing on the situation. While the author is giving practical points, as on page 18, as to information which should be obtained on reconnoissance work, why not include the question of good water supply, not only for the surveying parties to follow, but also for the contractors which follow later, and for the locomotives which follow still later?

Chapter III., on "Organization and Equipment," is excellent and very complete. Any party sent into the field with such an outfit as is recommended would certainly be well provided for.

Chapter IV. is entitled "The Preliminary Survey—Field Work." This chapter seems to be made up, to a large extent, of the nature of the duties of the various men of the field party, to the exclusion of more important ideas, such as the subject of grades and alinement, all of which matters the author seems to have reserved for Chapter VI., the "Location." The reviewer cannot but take issue with the author in relegating to a position of secondary importance the work on a preliminary survey, holding that it is on this survey that initial and full consideration (without the location refinement) is to be given to the subject of the alinement, adoption and local use of the ruling grade, and such features as placing the grade line safely above drainage, using light grades for stops at stations, water tanks, where there are passing tracks, where other railroads are crossed, etc. Also, on the preliminary, consideration should be given to the use of undulating grades and (if they are to be used) momentum grades.

On page 46, the author objects to the use of the term "Preliminary Location," as applied to the preliminary survey. However, it is hard to perceive how a preliminary survey does not practically become a preliminary location, when, as under the author's methods, the final location will lie within one or two hundred feet of the preliminary line. A preliminary survey should certainly be something more than a means of collecting and properly arranging information. While the economy of first cost and maintenance is largely determined by the ultimate or final location, yet the volume of business and economy of operation is largely dependent upon the situation of the line and the alinement and grades, which the preliminary line certainly fixes with more assurance than does the final location. Certainly, the majority of engineers will agree with the author in condemning the practice of running a preliminary location some little distance on the ground, and then, if not right, changing the same, backing up, etc. However, why not run a preliminary line (call it what you please, "Survey" or "Location") all the way through between definite fixed points, before the refinements of actual location are undertaken. Even the best locations are subject to revision, more or less radical, on construction, and the reviewer, at least, has had as many made, relatively, on lines located according to the author's methods as on what might be called the older and less refined methods.

The author's statement, on page 47, that, in attempting to make his first line a preliminary location, the engineer is likely to be influenced by it on the rest of his work, seems hardly reasonable. Certainly, what the author calls a final location survey, it being an adjustment of a paper location as determined by a picked-off grade line, results in holding and limiting the final location quite as much as any other form of location survey work. There can be no reason why just as many preliminary surveys should not be made and just as full consideration given them in one instance as in the other.

On page 48, the author states that there is but one place to project the actual location, and that on a good topographical map. This means, of course, within the reliable limits of the topography, only. Hence, the preliminary line adopted, whether it be called "Survey" or "Location," is in practical effect the best location the country affords.

The author, in a measure, puts on the shelf the locating engineer, with an "eye for country," yet, on page 49, he refers to the judgment of the locating engineer and his eye for country, and says that he should be trained to select, etc., evidently considering these characteristics as among the essentials of a good locating engineer, whether he use the author's refined methods or not.

The author seems rather extreme in certain methods and details. For example, pages 64 and 65: Compelling chainmen, when running in a curve and wishing to put a hub or instrument point at a plus, to run out the full length of the chain to get more approximately correct, seems a very unnecessary refinement, unless, indeed, it becomes necessary to run in the full curve by the establishment of quite a number of such pluses. In illustration, if a 4° curve were being run in and the instrument were at Sta. 328, and it were desired to set a hub at Sta. 330 + 30: If a hub were set by the ordinary method of chaining an even 30 ft., and with the deflection to correspond, such a point would be only .0057-ft. from a point on the curve proper, measured along the production of the line of sight, and only .00039-ft. from the curve proper, at its nearest point. These distances are entirely too small to enter into consideration in practical field work, and the practice of running out chain to its full length to enable a plus to be located a little more closely on the curve proper would seem a refinement quite unnecessary.

Chapter V., "Maps and Office Work," is comprehensive and the methods suggested are excellent, although some engineers may be equally well satisfied with a 2,000-ft. map in place of a 5,000-ft. map, particularly if there are county or other maps available, on which the line could be more or less accurately platted.

With regard to platting of preliminary lines, the writer is correct in recommending the laying off of the calculated courses from a meridian, but he might have stated that the method of "Latitude and Departure" should never be used in the field, it being too cumbersome and giving a refinement of accuracy quite unnecessary. The author recommends that location maps and profiles be returned from the field in 25-mile sections. Twenty-mile sections are preferred by many. The author does not recommend it, but it is a safe thing for the locating engineer to add 10% to all yardage quantities shown on his final location profile, making a note to that effect. In speaking of right-of-way maps and right-of-way, the author might have cautioned against the practice of many locating engineers, of cutting too close as to right-of-way requirements, and the further and more important feature of not giving sufficient consideration to the cost of right-of-way, in its relation to the whole cost of the line. Many locating engineers will make or consider changes in their location, to cover differences in cost due to grading, bridge work, etc., and give little or no consideration to a corresponding change in cost, due to right-of-way.

In the chapter on "Location" (page 116), the author speaks of compensation of grades, less than the ruling grade, as a small refinement, etc. This is so, but if the rate of grade is pretty close to the ruling grade, or if the uncompensated curve is close to an ascending ruling grade, care should be taken to see that, if compensation were added, the rate does not exceed that of the ruling grade.

The recommendation to use only curves of even degrees does not seem consistent [illegible] line with the other refinements and practi[illegible] advocated by the author. With a central [illegible]le of 60°, the difference in the length of th[illegible] external secant between a 3 and a 4° curve [illegible].71 ft. Certainly, in very many instances, a [illegible] between a 3 and 4 could be made to fit t[illegible] ground more desirably, and, at the same tim[illegible] reduce the tendency to chop up the grade line.

In speaking of fixing grade lines to [illegible] for stations, when station occurs on ruli[illegible] grade, introducing a break, the author says, 3[illegible] 400 ft. of level grade should be allowed beyo[illegible] where the engine will stop. Such a grade [illegible] not necessarily be level, but it should be [illegible] more than 0.4% of the ruling grade, and long [illegible]ough (considering its rate) to enable a [illegible]imum loaded train to reach the ruling grade [illegible] the desired rate of speed.

The author speaks, on page 121, of a conservative use of momentum grades, possibly permitting the use of a lower ruling grade. It must be a combination of exceptional country and conditions which would bring about such a result. The author is certainly correct in advising a very conservative use of momentum grades.

On page 129 is the expression (used in strengthening the author's position regarding his methods of location), "the general broad considerations which should properly govern the whole location." What are these broad considerations, except those which come up, or should come up, on the preliminary line and not on the location proper, when it (the location) is but the adjustment of the preliminary to best fit the topographical and other immediately adjacent features?

Chapter VII., on "Suburban Rapid Transit Railways," seems a little out of place in the text, considering the fact that the treatise seems designed as a text-book for schools and for the use of beginners. This chapter might possibly have been replaced, to better advantage, by one dealing with the ordinary problems encountered in field work, such as given by Henck and others.

In Chapter VIII., the author defines "Estimating," to a certain extent, as a matter of guesswork and judgment. He should, at least, have placed judgment before guesswork. There is no good reason why the estimate returned by an up-to-date locating engineer should include much guesswork. Such an estimate is but the opinion of the locating engineer as to what the features of construction referred to would, in his judgment, cost at the time he renders his estimate. If, in his report accompanying his maps, profiles and estimates, the locating engineer gives full explanatory reasons why and how he has arrived at his unit prices, no guesswork should enter into the proposition, whatever. It is certainly good practice for a locating engineer to return his estimated quantities of grading on his profile, to cover the condition of a possible pay-both-ways contract and of a possible haul-clause contract. The information on a profile which gives the free-haul and the overhaul, swell of material, etc., on every mile, is of great value to the constructing engineer and to the contractors as well, whether the work be done on a pay-both-ways or a free-haul basis.

In general review, the author might, consistently, have had more to say upon such points as water supply, its nature, quantity and quality; line being laid for convenient passing and industry tracks; stations; passing tracks between stations; location of line through cities and towns; yard room, etc., at division terminals; working in connection with right-of-way agents, political and diplomatic work in connection with subsidies, etc., etc.

Despite the reviewer's criticism of some of the author's methods, yet he quite agrees with the author that the method of location advocated by him is most thorough and up-to-date, and the best practice. The book is comprehensive, is an excellent epitome of good modern practice, and well adapted to the purposes for which it was designed.

Nitro-Explosives.

Reviewed by Chas. F. McKenna.*

NITRO-EXPLOSIVES.—A Practical Treatise Concerning the Properties, Manufacture, and Analysis of Nitrated Substances, Including the Fulminates, Smokeless Powders, and Celluloids. By P. Gerald Sanford, F. I. C., F. C. S., Public Analyst to the Borough of Penzance. Second Edition, Revised and Enlarged. New York: D. Van Nostrand Co. London: Crosby Lockwood & Son. Cloth; 5¼ × 8¾ ins.; pp. 300; 60 illustrations in the text. $4, net.

Few branches of technology can afford a parallel to the industry of high explosives where the intellectual energy dominating its beginning has penetrated through the years, put a premium on the prevention of the harmful uses of its products and continues to encourage the development of safer ones. In the fortieth year of the history of dynamite the prize of $40,000 yielded by the annual income from the accumulated profits of its manufacture has been awarded to our present most eminent American for his peaceful proposals and efforts in promoting the cessation of a war in which other and more novel nitro-explosives were the most energetic agents employed.

The discovery of Alfred Nobel was not that of the principle of the nitration of organic molecules; he merely adapted to safer use the substance which the less practical chemist Ascanio Sobrero had produced at Turin twenty years before in the form of tri-nitrate of glycerol. Nobel simply added the right absorptive powder, which thus made that most practical blasting agent which has since leveled hills and bored through mountains. If, however, this adaption discovery had not been made it is questionable whether the art would have so rapidly advanced, whether mixtures of nitro-glycerine and nitro-cellulose would ever have been hit upon or smokeless powders have resulted; for it was in the effort to improve blasting powder that gelatinization of nitro-glycerine with nitro-cotton was discovered. It has led also to the study of other explosives of the nitro class until we have a variety which meets every want; the quarry and the coal mine being no less important than the War Office.

Sanford's "Nitro-Explosives" is a work of much importance which has been a favorite authority in England, much consulted also in this country, and well merits the second edition. Its aim is that of the general treatise; theory is not so much dwelt upon as are the manufacture of the substances and their physical properties. The definition given is an excellent one as far as it goes, namely:

> The nitro-explosives belong to the so-called High Explosives, and may be defined as any chemical compound possessed of explosive properties, or capable of combining with metals to form an explosive compound, which is produced by the chemical action of nitric acid, either alone or mixed with sulphuric acid, upon any carbonaceous substance, whether such compound is mechanically mixed with other substances or not.

But it presupposes explosiveness, and that is the hardest to define. Explosives are substances which explode; but it is not amiss to point out when defining them that ideas are included of sudden decomposition, of generation of gases, high pressures and high temperatures. Almost as good would be his general statement a little further on:

> The nitro-explosives consist generally of some organic substance in which the NO_3 group, known as nitryl, has been substituted in place of hydrogen.

It can only be said that the second edition marks time and has not kept up with all the advances. The text is too much like the old, with some slight changes and explanations, and not at all enough reference to the progress in the manufacture of smokeless powders and insensitive blasting powders. The sections on the testing of high explosives, and on the stability and heat test, however, are not subject to this criticism.

There is very little of Berthelot in this book; there is much of Abel and other English authorities, and considerable information as to Cordite and Lyddite. It is still the rule in European countries to take the insular view of scientific progress. The Guttman heat test is given as new matter and the Bergman and Junk Prussian Testing Station method of testing nitro-cellulose is given. Excellent digests are included, amongst new matter, upon the analysis of Cap-Composition, particularly Jones and Wilcox methods and the Brownsdon method. Something that will probably be missed by American engineers consulting this work is information regarding safe methods of handling dynamite. Quite a chapter could be written upon this one branch of the subject. Transportation has lately given the American Railway Association grave concern, and has resulted in the formation of a Bureau to take charge of safe transportation and provide the proper inspection to assure the shipping of only safe explosives. Much good will come of this. If, in addition, the users of explosives in blasting will do less fool work in thawing frozen dynamite or in using electric light circuits for firing and in other criminally careless methods, there will be a shorter annual death roll from this modern agent of civilization.

There is found at the end of this volume a table of the composition of the commonly used explosives, which was a valuable feature of the first edition, and now contains some additional formulas; ten of them being for smokeless powders.

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Reinforced Concrete Tests at the University of Illinois.

TESTS OF CONCRETE.—I. Shear. II. Bond. By Arthur N. Talbot. Bulletin No. 8 of the University of Illinois Engineering Experiment Station. Urbana, Ill.: The University. Paper; 6 × 9 ins.; pp. 34; 11 illustrations, partly in the text, and 25 tables.

The excellent systematic test work on the elements of strength of reinforced concrete done at the University of Illinois has already resulted in the publication of two monographs (Bulletins 1 and 4). These dealt with beam-action as a whole. Two individual elements, each vitally important, are discussed in Bulletin 8, just published. This pamphlet summarizes tests of (1) the shearing strength of concrete and (2) the bond or adhesion between concrete and straight, plain bars embedded in it; the tests were made in 1905 and 1906. A valuable feature of the work is that the concrete materials involved were of representative quality; the cement used was the mixture of American Portlands furnished by the Joint Committee on Concrete and Reinforced Concrete. Sand and stone as well as cement were the same as used in the beam tests described in Bulletin 4. Equally valuable, to the man seeking for reliable results, is the consistence and uniformity of the individual results in each series.

The tests of shearing strength were based on recognition of the inadequacy of previously-used test methods, which led to the design of several new forms of test-specimen: a plain plate 13 × 13 × 3 ins., through which a hole was punched by a die 5⅞ ins. in diameter; a recessed plate, 13 × 13 × 5 ins., with a 6⅛-in. recess 2 ins. deep in one face; a similar recessed plate reinforced with steel around the base of the recess, both the latter two being punched with a 5⅞-in. die; and finally a 4 × 4 × 13-in. beam whose ends were strongly clamped while the free middle was sheared out by a die 4 ins. long. The tests showed that none of these test-methods is fully satisfactory, but that they are better than earlier ones. The figures of shearing strength obtained are somewhat too low, but they are not so improbably low as those which certain earlier experimenters found. The ultimate shearing strength in practically all cases exceeded 50% of the crushing strength, and often reached 75%. The author points out, however, that shearing and crushing strength are not accurately comparable, as the former may depend primarily on the stone, the latter on the concrete. The different series show averages from 750 to 1,800 lbs. per sq. in. of sheared section, in 1-3-6 concrete 60 days old.

The tests of bond, with plain round rods of mild steel, show averages varying from 350 to 450 lbs. per sq. in. surface, with somewhat higher value for 1-2-4 than for 1-3-5½ concrete. Cold-rolled shafting, tool steel, and flat bars of mild steel, gave much lower values, 100 to 150 lbs. per sq. in. In the different tests the steel at its point of emergence was stressed to from 4,000 to 40,000 lbs. per sq. in., but this variation had no recognizable influence on the bond strength. In all cases the slipping strength, or "running friction," was also measured, and it seems to average about one-half of the adhesive strength (32% to 72%). The various tests of bond reported in the pamphlet are remarkably uniform and concordant.

We may add that Bulletin 4 is again in print, and available for distribution "as long as it lasts."

A Notable Book on Alternating Current Motors.

Reviewed by W. S. Franklin,* M. Am. Inst. E. E.

ALTERNATING CURRENT MOTORS.—By A. S. McAllister, Ph. D. New York: McGraw Publishing Co. Cloth; 6 × 9¼ ins.; pp. 278; 122 illustrations in the text. $3, net.

This is a general treatise on single-phase and polyphase induction motors, synchronous motors and converters, and single-phase commutator motors. Chapter I. is a brief discussion of single-phase and polyphase circuits; Chapters II. to X. are devoted to polyphase and single-phase induction motors, including their use as generators; Chapter XI. is devoted to synchronous motors and converters; and Chapters XII. to XVI. are devoted to single-phase commutator motors.

The treatment is simple and instructive throughout, but the chapters on the induction motor are particularly noteworthy, containing, as they do, a very considerable amount of original matter which is of such character that the book must soon take a very high standing among books on the theoretical aspects of electrical engineering. The reviewer cannot better express his opinion of the book than by quoting from a letter he wrote to the author in the enthusiasm that came upon him after spending about eight consecutive hours in reading those points of the book that contain the really important contributions to the theory of the induction motor.

> I am greatly pleased with the book and I consider it the most complete, and I might say in some respects the only correct, treatise extant on alternating current motors. I have read with special interest the analysis of the internal actions of the single-phase induction motor, and the discussion of the magnetizing action of partially distributed stator windings.

The book is good, plain physics from beginning to end.

A POCKET-BOOK OF MECHANICAL ENGINEERING.—Tables, Data, Formulas, Theory and Examples. For Engineers and Students. By Charles M. Sames, B. Sc., Mechanical Engineer. Second Edition, revised and enlarged. Jersey City, N. J.: Charles M. Sames. Leather; 4 × 6¾ ins.; pp. 195; 40 illustrations in the text, and many tables. $2.

The first edition of this compact and convenient pocketbook was reviewed, for the most part very favorably, by Mr. Amasa Trowbridge, M. Am. Soc. M. E., in our issue of Dec. 14, 1905. In making ready the second edition, the author has very carefully compared his text with his original sources of information in order to correct possible errors, has replaced by later matter some of the information first given, and in addition has inserted an appendix of some 25 pages, or nearly one-sixth of the space occupied by the original matter. In this appendix, Mr. Sames says: "New subjects are treated, some omissions supplied, and much space given to recent and valuable matter relating particularly to machine design." These additions make up in part the deficiencies noted by Mr. Trowbridge in his review of the first edition. It should be understood, however, that the deficiencies mentioned are due to the small size of the book, and obviously cannot be avoided in so compact and low-priced a volume.

NATIONAL MUNICIPAL LEAGUE.—Proceedings of the Atlantic City Conference for Good Government and the Twelfth Annual Meeting of the League, Held April 24 to 27, 1906, at Atlantic City. Clinton Rogers Woodruff, Editor. Philadelphia, Pa.: The League (North American Building). Cloth; 6 × 8¾ ins.; pp. 502.

A volume of unusual size is required for reporting the last meeting of the League. Municipal conditions in various parts of the country, municipal ownership, uniform municipal accounting, and a variety of other subjects are taken up.

*Professor of Physics, Lehigh University, South Bethlehem, Pa.

The Cost of Locomotive Operation.

Reviewed by Arthur M. Waitt,* M. Am. Soc. M. E., M. Am. Soc. C. E.

THE COST OF LOCOMOTIVE OPERATION.—By George R. Henderson, M. Am. Soc. M. E. New York: The Railroad Gazette. London, England: The Railway Gazette. Cloth; 5½ × 9 ins.; pp. 192; 13 illustrations, partly in the text. $2.50.

Another valuable contribution to railway technical literature has been made in a compact volume by Mr. George R. Henderson, in which he treats Locomotive Operation from its financial side. Mr. Henderson has given much careful consideration to the general subject of Locomotive Operation, and his previous writings on the subject have been so admirable as to at once command attention and careful consideration for his latest work. The author does not claim to present absolute standards of cost value, but rather a discussion of the relation of varying conditions of service and locality to the cost of power production and suggestions of means of avoiding unnecessary expense, and operating at a minimum of cost. Mr. Henderson's long experience in touch with the practical side of Locomotive Operation on railroads and his peculiar faculty of analysis and comparison make the book one of exceptional interest to all those having to do with railroad motive power operations, as it is compiled with the purpose of clearing up many of the difficulties arising when an attempt is made to assign definite reasons for the frequent puzzling fluctuations in locomotive performance and operating costs.

In discussing the subject the various expenses are classified under three general headings—Supplies, Maintenance and Service—and each heading is subdivided into its elementary items, each of which is examined in regard to all phases of quality and quantity which affect the cost of operation, and also as affected by grade, speed, curves, loading, weather, etc.

Naturally "fuel" is first considered, it being generally the largest item of expense in locomotive operation. The various qualities of coal are referred to and mention is made of the principal features detrimental to good heat-producing results. A table is given showing the thermal values of the most prominent coals and lignites used for railroad purposes. The very frequent absence of any direct relation between the quality of coal and its price is made prominent by many illustrations which prove the inability to make intelligent comparisons of fuel costs as between different roads, or even different divisions of the same road.

The relation of "hauling" and the numerous methods of "coal handling" to the cost is set forth, together with the additional expense due to loss through "shrinkage" of various kinds, and also to "emergency storage."

The relation of the fireman, engine dispatcher, and the engineman to the economies of operation are briefly but forcibly set forth under the subheadings of "firing" and "running," while the effect of "design" and "condition" are also touched upon. Leaving the losses due to waste and deficiencies in maintenance or operation, a careful consideration is next given to the principal use of fuel, the production of "useful work." This subheading is simplified by the presentation of diagrams, devised by the author as a result of a series of practical tests, so that with a diagram constructed for any particular locomotive whose general dimensions are known, it will at once give the fuel consumption per mile or per hour at varying rates of speed.

Diagrams are shown covering the use of oil fuel with simple and compound engines and also where superheaters are used. An insert gives a series of useful diagrams and curves for calculating quickly the train resistance due to speed, weight, grade, curve, and loading, and a brief space is devoted to the discussion of each of these forms of resistance and their relation to the cost of operation.

The chapter on fuel concludes with remarks on the relation of speed of acceleration to fuel consumption, also the possible losses due to brakes, cost of making a stop, and effect of varying weather conditions.

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Chapter III. is devoted to water, which is shown to play a more important part in the expense of operation than it is usually credited with. The direct and indirect effect on costs due to the quality of water is first touched upon and many of the important indirect effects of bad water are cited. The price of water, as affected by the source of supply, pumping and various means of purification, is carefully presented. The chapter closes with a simple method of estimating quantities of water consumed per pound of fuel used.

A chapter on "lubricants" at the outset acknowledges the small part (1%) that lubrication for locomotives costs, yet it shows the various important features affecting this cost, such as quality of oil or grease used, cost of hauling and loss through defective appliances or improper practices. The presentation of this subject concludes with a consideration of the quantity of lubricants, and tables are given that may be taken as general guide for good average practice. As being associated with lubricants, the cost of "waste" as affected by its quality and quantity is briefly referred to, and a simple table is given for quickly arriving at an approximate cost for waste for various sizes and types of locomotives.

The further expenses of operation chargeable to supplies are referred to in a short chapter on "tools" and one covering "miscellaneous" supplies, such as sand, soap, metal polish, packing material, etc., and also including the cost of furnishing steam heat, electric lighting, etc.

The subject of Maintenance is presented under the headings of "general repairs," "running expenses," "renewals." As there has so far been no successful attempt to bring about on a scientific basis a comparison of cost of locomotive repairs, Mr. Henderson, under "general repairs," devotes himself chiefly to a discussion of various bases used for shopping locomotives and to citing some of the more up-to-date methods of keeping track of the work and the record of mileage; he also suggests means to curtail as far as possible the detention of locomotives in the shops. On the subject of "running repairs" numerous examples are given showing the unreliability of comparisons of costs based on engine mileage or ton mileage statistics. The author advocates a new unit as a basis for such comparative data which he calls a "draw-bar ton-mile" or a "tractive force ton-mile." Costs of "renewals" are shown in some of the various ways in which they are handled by railroads and the effect of the different policies on the cost of maintenance is clearly set forth, as well as the impossibility of making any general estimates which would be likely to conform to the published statements of costs of repairs.

In the chapters on "engineers" and "firemen" various schedules are presented showing the rates of pay per one hundred miles or less per day on several prominent typical roads for the different classes of service. The importance of the increase in cost due to overtime and delayed time are forcibly shown, and many of the causes for such increase are made clear. Reference is also made to the unremunerative classes of locomotive service, constructive mileage and light engine mileage. Pooling in its influence on expenses is touched upon, and the rapid increase in cost due to increase in speed is also referred to briefly.

In the chapter on "hostling and turning," data are presented which give a fair representation of the cost of this service, under the varying conditions due to different methods of performance. Under the headings of "cleaning fires," "wiping," "inspecting," "firing-up" and "calling" brief reference is made to the varying conditions pertaining to these items, and in each case an approximate idea is given of the costs of such service. The book closes with a chapter on "applications," in which the author makes an application of the preceding discussions and data for practical use. This is made clear by numerous hypothetical cases which are quite fully worked out. In this chapter a very helpful diagram is given for quickly arriving at the effect of speed and weight of train upon cost and hauling capacity, and other useful diagrams are worked out to simplify the speedy obtaining of the most economical practices in engine loading suited to varying local conditions. A very simple index is provided at the end of the book.

"Cost of Locomotive Operation" is a book that should be in the hands of every railroad officer who has in anyway to do with the supervision or criticism of locomotive operation and its cost. Its salient points, if kept actively in mind will go far toward bringing about an era of co-operation between the officers in charge of train operating and the motive power officers, which will surely tend to a material improvement in service and a reduction of costs to nearer the minimum.

TECHNISCHE HUELFSMITTEL ZUR BEFOERDERUNG UND LAGERUNG VON SAMMELKOERPERN (MASSENGUETERN).—By M. Buhle, Professor in the Royal Technical College at Dresden. Part III. Berlin, Germany: Julius Springer. Cloth; 9½ × 12¾ ins.; pp. 322; folding and other plates and many text illustrations. 24 marks; American price, $9.60.

The third volume of Prof. Buhle's work on Methods and Machinery for Handling Bulk Freight has precisely the same characteristics, favorable and unfavorable, as the two volumes that preceded it, already reviewed in these columns. The contents are a series of reprints of separate articles dealing with individual parts of the subject, published at various times in different German technical papers. To make the book, these articles have been merely put together as separate chapters, without connection or sequence, and without disassembling and rearranging. In consequence the book presents at the same time much annoying repetition (even of cuts), and great unfilled gaps in the subject matter. The treatment is descriptive throughout, and for the most part is a mere exhibition of types of apparatus, illustrated largely by half-tone photographs, such as are found in catalogues. The book is therefore virtually an album of types of machinery and plant, with a general text description; by no means a comprehensive album, nor balanced (in the sense of devoting proportionate space to the several branches of the subject).

It is unfortunate that the author, having a wide familiarity with the class of machinery described, should not have found time for some analysis and arrangement of the matter he accumulated. The size and excellent mechanical make-up of the work are worthy of a more solid text.

It will, of course, be understood that the work is not without great value. The field covered is so extensive and well-developed, and is so poorly represented in technical literature, that the amount of material here brought together cannot fail of utility. But it might easily have been made far more useful.

The lack of arrangement within each volume characterizes also the series. There is no apparent grouping or progression to differentiate Vol. III. from Vol. II., and the individual chapters of the three volumes might just as well have been shuffled and dealt out in any chance set of three lots. To denote the contents of this volume we can therefore only give chapter heads, selecting the more important: On Bulk Transportation; The Kreiss Oscillating Trough-Conveyor; Rapid Unloaders; Conveyor Machinery of H. Köttgen & Co.; Some Conveyor Systems and Plants; Cable Switching-Yard Machinery of C. W. Hasenclever Sons; Electric Mine and Surface Locomotives of W. Lahmeyer & Co.; Recent American Freight Cars, etc.

CONDITIONS HYDRAULIQUES DES GRANDES VOIES NAVIGABLES DU GLOBE (Hydraulic Conditions of the Navigable Waterways of the World).—By E. L. Corthell. Translated into French by Henri Vicat. Memoires de la Societe des Ingenieurs Civils de France. Paris. Paper; 6 × 9 ins.; pp. 176; with folding tables.

This paper gives particulars of the tides, rise and fall, currents, and other hydraulic conditions of rivers, canals, harbors, etc., throughout the world, together with notes as to the traffic and other commercial features. The information is summarized in tabular form, and the illustrations consist of a map, section and tide diagrams of the proposed Cape Cod ship canal.

Geodesy and Least Squares.

Reviewed by John F. Hayford.*

TEXT BOOK ON GEODESY AND LEAST SQUARES.—Prepared for the Use of Engineering Students. By Charles L. Crandall, Professor of Railroad Engineering and Geodesy, Cornell University. New York: John Wiley & Sons. London, England: Chapman & Hall, Ltd. Cloth; 5¾ × 9¼ ins.; pp. 329; 102 illustrations, mostly in the text, and 13 tables. $3.

Professor Crandall has been teaching geodesy in the College of Civil Engineering at Cornell for more than a quarter of a century. The matter contained in this book has been continuously under revision during all that time. The germ of this book first existed as lecture notes. Later these were printed each year by the mimeograph, or some equivalent process, and put in the hands of students. Now for the first time they are printed as a book. During this whole period the classes in civil engineering at Cornell under Professor Crandall and others have been given field practice in geodesy which is a remarkably good imitation of actual experience. Professor Crandall has, during the whole period, kept closely in touch with geodetic operations through the literature of the subject, by some service in the field and by visits to geodetic field parties. Professor Crandall believes that both the student and professor should work hard in a joint attempt to gain as much accurate working knowledge as possible of the subject in hand during the limited time available. He apparently does not believe that the professor should set himself so limited a task of teaching and perform it so well that the student may simply follow the professor easily through the subject, along a smooth and comfortable path.

A prediction of the defects and excellencies of the book, based logically upon the preceding paragraph will be found correct.

The contents of the book in order are: A historic outline of geodesy in 12 pages; triangulation and reconnaissance, 82 pages, of which more than one-half deals with the construction, testing and manipulation of the instruments involved; base line measurements, 31 pages, of which one-half is devoted to careful descriptions of the various types of base apparatus which have been used; trigonometric leveling, 8 pages; precise leveling, 22 pages, being a concise and well-illustrated statement of the instruments and methods which have been used; 31 pages deal with the various formulas which are needed in connection with geodetic computations and the plotting of map projections; 5 pages are devoted to a system of rectangular spherical coordinates used in Europe; the determination of the dimensions and shape of the ellipsoid from triangulation and astronomic observations is treated in 13 pages; a statement, in the general form, of the method of Least Squares as used, accompanied by examples, occupies 45 pages and is followed by 18 pages, stating the theory which forms the basis of the method. The text closes with 29 pages dealing with the application of the method of Least Squares to triangulation, leveling, and to compass and transit surveys. The remaining 33 pages contain tables and a good index.

The book is an excellent and well-balanced statement of past and current practice, prepared with rare good judgment as to the relative importance of things. It is especially to be commended as being thoroughly up-to-date. In fact, some of the features of recent practice in the Coast and Geodetic Survey are here stated before that Survey has put them into print.

The student, unassisted, will have difficulty at many points in seeing the relation between the facts presented, for the reason that the principles involved are not fully and clearly stated. For example, to an expert in base measurement the chapter on that subject is exceedingly interesting and is clear. But much of the essence of the chapter will escape the student. It could be brought within his grasp by one or two pages calling attention clearly to the principles involved in and illustrated by the apparatus and methods which are described.

The student is not led forward by showing him clearly in advance the purpose of a given chapter. Steps in the reasoning essential to an easy understanding are omitted, critical comments on the relative merits of conflicting practices are insufficient and the condensation of statement is severe throughout the book. The penalty paid is abstruseness in many places. It would require great energy to compress more into 329 pages than has been put into this book. But the very fact that it has been packed in so tightly makes it difficult for the student to get it out again.

If the book is supplemented in the class-room by lectures, and references to other books, designed to remedy the defects indicated, it will be found to be the best book on geodesy now available in English. The engineer in practice will find it a most excellent and suggestive reference book.

The reviewer may be prejudiced. He learned geodesy as a student under Professor Crandall and while applying his knowledge wrote the originals of many statements of present practice in the Coast and Geodetic Survey which appear in condensed and but slightly modified form in the book.

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THE ELASTIC ARCH.—With Special References to the Reinforced Concrete Arch. By Burton R. Leffler, Assoc. M. Am. Soc. C. E., Engineer of Bridges, Lake Shore & Michigan Southern Railway. New York: Henry Holt & Co. Cloth; 5 × 7¾ ins.; pp. 57; five folding plates. $1.

The author presents a working method for locating by graphics the pressure curve in fixed-end, solid-rib arches, aiming specially at the design of reinforced-concrete arches. He condenses his subject into very small compass, and evidences that his ideas throughout are on sound foundation. Unfortunately, the explanation at many points is far from being clearly put, so much so that the reviewer needed a careful second perusal to understand the main part of the directions for the graphical operations. In recommending the little work to the civil engineer, therefore, we can address ourselves only to the careful reader, the one who uses a text only as a guide by which he works out the principles and deductions independently. To such a one the book will be a handy means for learning the graphical analysis of stone and concrete arches considered as fixed at the ends. It should thus help to lead to a better understanding of the degree of approximation involved in the very common method of passing the equilibrium polygon through arbitrarily selected points, as, for instance, the middle points of the end sections and the edge of the middle third of the crown section.

The work is individualized by numerous strongly-worded opinions, notably some given in the Appendix, where will be found, among other remarks, an interesting definition of civil engineer and several slaps at "invested interests" in reinforced-concrete construction.

It is hardly fair to attempt to criticise in detail a text so condensed as this. The language impresses one as though the book had been written at one sitting and by a hand unused to precise writing. In consequence, the text is occasionally quite obscure; more frequently it misleads the reader, a mild instance being the sentence:

> It must be remembered that for a perfectly elastic arch the pressure curve may fall entirely out of the arch ring,

where the author means much less than he says. As already said, therefore, we can commend the book only to the careful and intelligent reader.

COMPOSITION AND CHARACTER OF ILLINOIS COALS.—By S. W. Parr. With Chapters on the Distribution of the Coal Beds of the State, by A. Bement, and Tests of Illinois Coals under Steam Boilers, by L. P. Breckenridge. Bulletin No. 3, Illinois State Geological Survey. Urbana, Ill.: Pub. Doc. Paper; 5¾ × 8¾ ins.; pp. 86; 5 plates and 16 text figures.

The State of Illinois is not ordinarily thought of as a mining State, but for many years it has been second only to Pennsylvania in coal production in the United States. The magnitude of the industry has caused the lately-organized Geological Survey to publish this document. The investigation is still in progress and this bulletin is in the nature of a preliminary study. The production of coal, while not showing the rapidly diminishing supply that is evident in timber, has reached a point where it is necessary for the development of more scientific and economic methods of mining. As a help toward the knowledge of conditions surrounding the formation and occurrence of coal and consequently its production a bulletin giving information about such a large field is of value.

THE SLIDE RULE.—A Practical Manual. By Charles N. Pickworth, Whitworth Scholar, Author of "Logarithms for Beginners," "The Indicator: Its Construction and Application," "The Indicator Diagram: Its Analysis and Calculation," etc. Tenth Edition. Manchester and London, England: Emmott & Co., Ltd. New York: D Van Nostrand Co. Cloth; 5 × 7¼ ins.; pp. 104; 24 illustrations in the text. $1.

A little over three years ago (Oct. 15, 1903) the eighth edition of Pickworth's Slide Rule was reviewed in these columns. The comments we made at that time may be applied with little change to the present edition. The text appears to be simplified and improved, there is a large number of illustrative examples from various phases of engineering calculation, and some few of the numerous modified and special slide rules are described. The book is undoubtedly a serviceable means for helping anyone to acquire quickness and facility in the mechanical handling of the slide rule. Whether its statement of the mathematical principles is as lucid as it might be is more open to doubt.

As in all other dissertations on the use of the slide rule, much space is given to methods for finding the position of the decimal point. Such methods, both when stated in words and when applied, are actually more complex and bothersome than the determination of the desired products of quotient itself. This fact would not matter if it were vital, or even important, to fix the number of digits in the answer by a mechanical procedure. But we ourselves have never employed any such procedure, and doubt whether many users of the slide rule have recourse to anything but inspection of the given factors. If we are right in this opinion, then the author has cumbered his book with many paragraphs of useless matter.

FORMELN UND VERSUCHE UEBER DIE TRAGFAEHIGKEIT EINGERAMMTER PFAEHLE. — (Formulas and Tests on the Bearing Power of Piles.) By Philipp Krapf. Part 12, Group II., Fortschritte der Ingenieurwissenschaften. Leipzig, Germany: Wilhelm Engelmann. Paper; 7¼ × 11 ins.; pp. 28; two folding plates and eight text illustrations. 2 marks. American price, 80 cts.

After a theoretical consideration of the mechanics of pile-driving, the author lists various pile-formulas and expresses a preference for the form (credited to Prof. Kreuter of Munich):

$$Ph = Wd + K$$

or, with a correction coefficient,

$$W = k \frac{Ph}{d} - \frac{K}{d}$$

where W is the ultimate load of the pile,
P is the weight of the hammer,
h is the fall of the hammer,
d is the penetration for the last blow,
K and k are constants.

He then details the methods and results of several pile-driving and pulling tests conducted for the purpose of determining k and K. The factor k, which may be called the efficiency ratio, varied from 0.31 to 0.67 in the different tests. The surface friction determined by the pulling tests was: 145 lbs. per sq. ft., 295, 355, 345, 625, and 380 lbs. per sq. ft., in six different tests, all of which were made in soft ground (clay to marsh and silt bottoms).

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The Marine Screw Propeller.

Reviewed by D. W. Taylor.*

DIE SCHIFFSSCHRAUBE.—By Albert Achenbach, Principal of the Royal Naval Academy at Kiel. Part II. Its Detailed Design; with an Appendix, Screw Propulsion of Motor Boats. Kiel, Germany: Robert Cordes. Cloth; 6½ × 9½ ins.; pp. 152; 20 plates and 18 tables. 14 marks; American price, $5.60.

This is the second volume of a three-volume work and is devoted to the construction of propellers. The first volume, upon the historical development of the screw propeller and methods of graphic representation, was reviewed in Engineering News of April 12, 1906. The third volume, upon the theory and design of screws, has not yet appeared.

In the volume now in hand the author devotes 111 pages to ordinary screws of all types and the remaining 51 pages to motor boat propellers. The main portion of the work contains copious illustrations and tables of data showing the detailed construction of a number of German propellers for naval and commercial vessels. The author discusses such questions as the material of screws, the design of hub when the blades are bolted on and when they are cast in one with the hub, methods of securing blades, including various methods for locking on the nuts which hold the blade flanges to the hub, methods of securing the hub to the shaft, fairwaters behind hubs, etc. In taking up a detail the author enumerates a number of the principal dimensions to be considered, gives some little discussion of the same from a practical point of view, and follows with tables showing the principal dimensions in question for several sizes of propellers for a number of different types of vessels. For instance, in connection with securing hubs upon their shafts, the author considers the taper of shaft, the key or keys, the screwed end of the shaft for the nut, and the nut itself. He gives data on these matters for two battleships, four cruisers and two torpedo boats of the German navy, and for merchant vessels he gives similar data for three river and harbor boats, three sea-going boats with solid propeller wheels, and three sea-going boats with blades bolted on. In addition to giving the actual data he shows in his table the relations of the various leading dimensions to the prime variables, so to speak, in the case. For instance, the ratio between the length of the coned portion of the shaft and the diameter of the shaft and the ratio between the smallest diameter of the cone and the diameter of the shaft. This portion of the work appears to cover very fully current German practice in the design of propeller details.

The author appears to be still enthusiastic over the Niki patent propeller, whose essential feature is that the blades are stepped axially on the hub. He states that numerous experiments are being tried with it on various types of German vessels, and hopes in his final volume to give comprehensive data and discussions of results of experiments.

The 13 pages devoted to making patterns of, casting, finishing in the shop, measuring the pitch of, and securing in place propellers are hardly adequate to cover satisfactorily the subjects treated, and are rather sketchy.

The appendix upon propeller gears of motor boats gives information concerning a number of different reversing clutches and gears for feathering or reversing the blades. With the exception of a brief description of the original Bevis feathering screw of 30 years ago, this appendix is devoted entirely to descriptions of apparatus made by various German firms, and is made up largely from information taken from catalogues or supplied by the manufacturers.

The greatest value of this book consists in the copious information it gives concerning current German practice in the construction of screws. The author has given very little discussion of underlying principles, this being presumably reserved for the third volume. As a result there are a few cases where statements are of little practical value without further theoretical explanation, which is not given. For instance, in discussing the question of securing propeller blades, the author states that the area of the studs in the hub is made from 60 to 90% of the sectional area of the shaft. This variation is too great for purposes of practical design, and as a matter of fact the area of these studs is dependent upon other factors than the diameter of the shaft; such, for instance, as the pitch ratio of the propeller and the distance of the blade flange from the center of the shaft.

In a discussion of the general features of actual screws (pages 16 and 17) the author appears to consider that raking or inclining blades aft tends to increase the efficiency of operation. This is a disputed point and by no means generally admitted. He states further that the angle of inclination aft of the blades reaches as much as 20°, is usually about 8°, and is greater the higher the revolutions. This statement may be correct as regards German practice, but if so the practice is clearly wrong. Dr. Bauer, the author's compatriot, has called attention to the increase in centrifugal stress upon a propeller blade when it is raked aft, and, as a matter of fact, the stresses due to centrifugal action for blades which rake aft become excessive at high speeds of revolution, and quick-running screws should have very little, if any, after rake.

The make-up and typographical work of this volume is excellent. It seems curious to see here and there in the tables some dimensions in English units. All outside diameters of screws appear to be given in inches. In a number of places the division sign is used in a manner unknown in this country. For instance 4,000 ÷ 5,500, on page 20, does not mean the fraction $^{4}/_{11}$ but "from 4,000 to 5,500."

The author's main purpose in this volume has been to give comprehensive and detailed information as to current German practice in the construction of actual screw propellers, and this purpose has been accomplished very well. There is no work which covers this particular field for English or American practice with such thoroughness, and this volume should be useful to all engineers who have to do with the details of propeller design and have even a moderate knowledge of German.

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Boiler-Waters.

Reviewed by G. C. Whipple,* Assoc. M. Am. Soc. C. E.

BOILER-WATERS.—Scale, Corrosion, Foaming. By William Wallace Christie, M. Am. Soc. M. E., Consulting Engineer, Author of "Chimney Formulae and Tables," "Chimney Design and Theory" and "Furnace Draft: Its Production by Mechanical Methods." New York: D. Van Nostrand Co. Cloth; 6 × 9¼ ins.; pp. 235; 77 illustrations in the text, and numerous tables. $3, net.

This work is devoted to a discussion of the properties of water as they affect the manufacture of steam, to the effects of impure water on boilers, and to various methods of water softening. In scope it is similar to several other books which have been recently published, but it is somewhat differently balanced with respect to the three topics mentioned. Greater emphasis is given to the injurious properties of hard waters, and the illustrations of corrosion, boiler scale, etc., are particularly well set forth. This is by far the most interesting and valuable portion of the book. The discussion of the chemistry of boiler-waters is elementary and superficial. The attempt to furnish simple tests for the use of engineers is far from satisfactory. Some of the best methods of analysis are not given, while other descriptions are incomplete. Furthermore, confusion is introduced by the use of many different methods of stating results. On one page will be found analyses expressed in "grains per U. S. gallon"; on another "grains per Imperial gallon"; while on a third the figures refer to "parts per 100,000." The theory of water softening is passed over in few words, but the descriptions of water softening plants as related to steam making are clear and concise. The book is well printed and unusually well illustrated.

*Of Hazen & Whipple, Consulting Engineers, 220 Broadway, New York City.

Machine Designs.

Reviewed by Amasa Trowbridge,* M. Am. S. M. E.

MACHINE DESIGN.—By Charles H. Benjamin, Professor of Mechanical Engineering in the Case Sch. of Applied Science. New York: Henry Holt & C. Cloth; 5 × 7½ ins.; pp. 202; 84 illustrations, mostly the text. $2.

The above is intended as a text-book for t use of students, and while very useful for th purpose is not complete enough for the requir ments of the practical designer. It has the fa that is common to most books bearing its tit that is, it covers only a small part of the subje

The principal things in the book which ar valuable are the results of experiments pe formed on various springs, journals, fly-whee etc. This matter is partially new, and, being pr sented in connection with rules for the design o similar parts, its bearing on their design is qui apparent. A very short chapter is given on t subjects of frames and supports for machin The information under this head is good b very scant. The subject is one that cannot b treated adequately in a few words, and one th deserves considerable space. The chapter on fly-wheels is the most valuable part of the book. In it the author has given data that are very useful to the designer of high-speed engines and steam turbines. He also gives some very good rules for the design of gears, pulleys and cranks that are not found in pocket books.

Under the head of bearings, the author considers principally ball and roller bearings. This is a comparatively new subject, and data concerning it are scarce; hence this part of the book would be found useful by almost every designer.

THE CONSTRUCTION AND CARE OF BRICK PAVEMENTS.—By Ira O. Baker, M. Am. Soc. C. E. Chicago: Clay Record Publishing Co. Paper; 5 × 7¼ ins.; pp. 24. 25 cts.

This is a reprint of an article in the "Clay Record," and the article itself formed part of the report on "The Paving Brick Industry of Illinois," prepared for the Illinois State Geological Survey, but not yet published. The treatment is concise and practical. As to the foundation, it is suggested that broken stone and gravel will often be as good as concrete (especially poorly made concrete), and that if concrete is used it is not always necessary to have the 6-in. thickness which is now almost universally adopted. It is not considered economical to use a heavy concrete foundation simply because trenches may not have been properly backfilled. The bricks should be laid on a 2-in. cushion of sand. The inspection, testing and laying of brick are all dealt with, as are also the respective merits of sand, tar and cement-grout fillers.

LEITFADEN DER BAUSTOFFLEHRE (Syllabus of Materials of Construction). Für die Hochbau und Tiefbau Klassen von Baugewerkschulen sowie zum Gebrauch in der bautechnischen Praxis.—By Dr. Heinrich Seipp, Director of the Royal Building Trade School at Kattowitz. Boards; 6¾ × 9½ ins.; pp. 103; 29 illustrations in the text. Leipzig: H. A. L. Degener. M. 1.50. American price, 60 cts.

A concise, clear and comprehensive syllabus or condensed treatise of constructive materials. Its space is apportioned as follows: Natural stone, 20 pp.; Burned artificial stone (brick), 14 pp.; Mortars, 19 pp.; Unburned artificial stone, 3 pp.; Timber, 19 pp.; Metals, 12 pp.; Glass, 5 pp.; Paints, 5 pp.; Lutes and Asphalt, 5 pp; Other materials, 2 pp.

*811 St. Nicholas Ave., New York City.

WANTED
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An Up-to-Date Cement Book.

Reviewed by Frederick H. Lewis,* M. Am. Soc C. E.

PORTLAND CEMENT.—Its Composition, Raw Materials, Manufacture, Testing and Analysis. By Richard K. Meade, B. S., Chemist to the Dexter Portland Cement Co., Editor of "The Chemical Engineer," Author of the Chemists' Pocket Manual, etc. Easton, Pa.: The Chemical Publishing Co. Cloth; 5¾ x 9¼ ins.; pp. 38[illegible] 100 figures, mostly in the text, and 49 tables. $3.50

The book literature on cements in the English language may broadly be characterized as dry, colorless, lacking distinction, without originality or special value of any kind. This does not mean that the contributions made by English-speaking men to this branch of practical science have been insignificant or valueless. Many papers, reports and reviews have appeared from the time (1877) of John Grant's notable papers read before the Institution of Civil Engineers to the present date. Many of these have lacked neither originality, scientific value nor distinction. But the books have not been on an equal plane. General Gillmore's "Limes and Cements" was and still is a valuable book for American readers, because it was a practical and careful collection of the facts regarding American materials and manufacture at the time it was written. With this exception the books are of such a character that any one cognizant of them approaches a new one without enthusiasm, expecting to find in it the old familiar historic review, with a little chemistry, a little comment on machinery and manufacture, and rather too much on testing, and not expecting to find that practical accuracy of figures, methods and details which is so essential to the modern man and which he is continually seeking.

Mr. Meade's book is, therefore, an agreeable surprise. Dismissing the hackneyed historic features, which seem to be necessary to all cement literature, the book is found to be one which fairly represents to date the American Portland cement industry, as seen from the standpoint of the technical staff. As a practical book from this standpoint nothing at all equal to it has hitherto been published, either in English or foreign literature, and Mr. Meade is to be congratulated, therefore, on a really notable effort. For the time being it is quite sure to find a place in every cement work's laboratory, in the hands of every chemist studying this subject, and as a book of reference for many others who have to deal with cements in one capacity or another.

While the chapters on "Proportioning Raw Material" and on "Analytical Methods" are naturally the strongest in the book, fuller in detail and more copious in figures and formulas, yet Mr. Meade deals with machinery and processes of manufacture extremely well. These chapters represent the intelligent observation of a man who, though not in responsible charge of these features, yet has them under daily observation, and is familiar with the general facts, with the trend of opinion, and the modifications of practice. The facts and figures given under these headings are free from essential error. They could be amplified, but they will not be criticised in any general terms. Manufacturers as a class would be glad to see their costs kept within some of the figures given, but will hardly be prepared to contend that these figures cannot be realized.

To the reviewer, one notable omission in the formulas for proportioning raw material is the absence of the percentage of volatile matter from all the formulas. It is true that this factor is not necessary in factory practice dealing with reasonably uniform raw materials. In Pennsylvania, is has been established that 75% or 75.5% $CaOCO_2$ is a normal cement mix. In the purer limestones, also, the volatile matter is almost entirely carbonic acid. But in dealing with new and untried materials a correct mix can only be arrived at from a formula which considers the volatile matter. Shales and clays after drying at 212° are found to contain varying percentages of volatile matter, and sometimes as much as 8% to 12% of volatile matter which is not carbonic acid.

Mr. Meade has brought his testing methods up to date by following the recommendations of the American Society of Civil Engineers and of the American Society for Testing Materials, and thus furnishes another reason for putting older treatises on the shelf. He commits a singular error in ascribing the boiling test devised by Dr. Michaelis, of Berlin, to Professor Tetmajer, of Zurich, but in general has collated his data from all sources in excellent shape.

Undoubtedly the book will be well received by the many people interested in cements, and will occupy a place in cement literature which everybody has known was vacant and which should be filled by some one competent for the task.

*Consulting Engineer, Leeds, Ala.

A New Theory for the Study of Turbines.

Reviewed by Storm Bull.*

NEUE THEORIE UND BERECHNUNG DER KREISELRAEDER.—Water and Steam Turbines, Centrifugal Pumps, Fans, Turbo-Compressors and Propellers. By Dr. Hans Lorenz, Professor of Mechanics in the Technical College at Danzig. Munich and Berlin, Germany: R Oldenbourg. Cloth; 6½ x 9½ ins.; pp. xiii. + 144; 67 illustrations in the text. 8 marks; American price, $3.20.

During the last two years Dr. Lorenz has published a number of articles on the subject of this book in the "Zeitschrift des Vereins deutscher Ingenieure" and in the "Zeitschrift fur das gesammte Turbinewesen," especially in the latter, and it is these articles which the author now has revised and put into the form of a book. The name of the book indicates very precisely its contents. It contains a *new* theory which the author bases directly on the fundamental theorems established 150 years ago by Euler, and it is therefore not affectation when the book is dedicated to the memory of Euler. Of necessity there is a very large amount of mathematical work in the book, and a thorough knowledge of calculus is required of the reader. If the reader is not frightened away by this fact he will, however, find that this new theory furnishes a much more complete and accurate knowledge of the flow of water through the turbine wheel than the old theory, thus enabling the designer to determine the dimensions of the buckets. The book also contains methods of computation, and its value is certainly very greatly increased by the numerous examples which it contains and which are completely worked out.

As a curious fact it may be mentioned that Dr. Lorenz, on the basis of this new theory, comes to the conclusion that the radial turbine must of necessity be superior to the axial one, a conclusion which is not shared by Gelpke in his recent book on turbines, reviewed in these pages only a couple of months ago.

One of the most attractive features of the book is that this new theory applies not alone to water-turbines, but also to steam-turbines, centrifugal pumps, turbo-compressors and ship-propellers, and for each of these machines the author gives numerical applications. The recent great progress in the efficiency of the centrifugal pump is, according to the author, only due to experimental work, done especially by Sulzer, of Winterthur, Switzerland. The theory of the author, however, discloses the rules according to which such pumps must be designed to attain a high efficiency. This statement also applies to the ship-propeller, which, as is well known, is very far from being as efficient as it should be.

The book is very clearly written, the mathematical parts being in this respect models of their kind. The illustrations and typography are excellent.

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PRACTICAL LETTERING.—For Beginners, Draftsmen, Engineers, Engravers, Sign-Painters, Stone-Cutters, Lithographers, etc. With Original System for Spacing. By Thomas F. Meinhardt. New York: The Norman W. Henley Publishing Co. Paper; 13¾ x 8¾ ins.; pp. 15. 60 cts.

The name of this pamphlet does not properly designate its contents, which include the presentation of a system for spacing, supplemented by various hints on copying and hectograph duplicating. Lettering is only mentioned in "Comment" upon a page of alphabets contained in the work. The "Original System of Spacing" appears to be quite similar to the one given in Prof. H. S. Jacoby's "Lettering."

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Gold Mining Plant.

Reviewed by Walter R. Crane.*

GOLD MINING MACHINERY.—Its Selection, Arrangement and Installation. A Practical Handbook for the Use of Mine Managers and Engineers, including Particulars for the Preparation of Specifications and Estimates. By W. H. Tinney, M. Inst. M. and M. New York: D. Van Nostrand Co. London, England: Crosby Lockwood & Son. Cloth; 5¾ x 9¼ ins.; pp. 308; 97 illustrations, mostly in the text. $5, net.

As indicated in the preface, the aim of the author has been to bring together material, collected from many and varied sources, and present it in a form convenient for immediate reference. The author has felt the need, in his own practical experience, as have all engineers, of having certain data available for use in making calculations and estimates for installations of machinery, power plants, and other detailed mine constructions.

The discussion of steam generation, together with its loss and the consequent loss of power, is briefly and concisely stated. Water motors, gas and oil engines and electrical motors are disposed of in a few pages and almost too summarily for a comprehensive discussion.

The chapter on engine erection, which includes building, leveling and alining foundations, assembling the parts and adjusting the engine preparatory to making steam connection, is excellent in most particulars. It would not, however, have been out of place to have described briefly temporary foundations and foundations on unstable ground, which are often necessary to build and are extremely trying, especially to those unfamiliar with their construction.

The author recognizes the importance of the proper choice of boilers for the steam plant and gives some valuable and useful information and sketches for the setting of boilers, and regarding the kind and construction of chimneys. The heating effect, or the steaming value, of coals and woods are briefly discussed, together with facts regarding feed water, means of purifying it, etc. Further, some practical information is given regarding the examination of boilers, care and operation of engines, and the taking and interpretation of indicator cards.

The various kinds of pumps adapted to mining work, under varying conditions of depth and volume of water to be handled, are treated in a more or less desultory manner. Only a comparatively few of the more important makes are mentioned and relatively too much space is given to others of less importance. For instance, fully six pages are given to a discussion of Cornish pumps, while less than two pages are occupied with a description of a pump of the Riedler class. Nothing in particular is said regarding sinking pumps, while the electrically driven forms of mine pumps are passed practically without mention; however, some useful information in the form of tables and other data are presented in convenient form.

The author's outline of winding machinery leaves much to be desired, considered from the standpoint of modern practice, although it must be borne in mind that there are certain limitations imposed by a description of one branch of mining only, which in this case is gold mining. Brief descriptions regarding care of rope, together with rules for calculations of sizes, and also directions for splicing, are furnished. The use of cages and skips, together with their common sizes, are given.

Much more could have been said to advantage with respect to the design and construction of head gear. In fact, too little attention is usually given to such constructions, the approximations made, regarding sizes of members, etc., amounting to little more than guess work. Further, the illustrations of head gear, especially the steel forms, are far from being typical, at least of American practice.

The chapter on air compressors is necessarily incomplete and unsatisfactory, for the reason that it is practically impossible to give an adequate idea of such an important and extensive subject in a work of this character. Under the circumstances the author has done fairly well.

The treatment of air drills is excellent; however, it is rather unfortunate that diamond drills should have been put in the same class. It would have been preferable to put them under a separate head, as, for instance, prospect drilling.

In the chapter on reduction of ores are remarkably good descriptions of all the machinery employed in such work, including crushers and stamps for preliminary work and rolls and ball and tube mills for finishers. Considerable working data are also given which make the chapter especially valuable. Not so much can be said, however, with regard to the treatment of concentrating machinery, although some valuable data are given. The chapter is, as a whole, incomplete and unsatisfactory. As the treatment of the gold ores stands second to no other operation, in their reduction from ore to bullion, the machinery used in the different processes deserves greater consideration. Further, no mention is made of the chlorination process, although it may still be considered to be of some economic importance.

The transmission of power by shafting, belts, ropes, compressed air and electricity is briefly discussed, but probably fully enough for the work in hand, except the use of compressed air and electricity, which are hardly more than mentioned. This is unfortunate, as electricity, especially, is becoming one of the most important means for the transmission of power for long and short distances, and especially for mining work.

The chapter on transport is not exhaustive enough and lacks details, but what is given is fairly good.

Considerable valuable information is given on piping and joints, and many good suggestions are to be found in the chapters on construction and tackle and tools, which will be appreciated by both manager and millwright.

In conclusion it might be said that the rules and formulas given are, as a rule, too approximate and show the lack of careful mathematical analysis. This work is, of course, too limited in its scope to enter into extended mathematical demonstrations, but definite rules mathematically expressed would not be out of place. Further, for American engineers the practice in the United States could have been cited to greater advantage. Lastly, more references as to the source from which much of the material was derived should have been given in order that the reader might get more detailed information regarding the points referred to.

A SHORT COURSE ON DIFFERENTIAL EQUATIONS.—By Donald Francis Campbell, Ph. D., Professor of Mathematics, Armour Institute of Technology. New York: The Macmillan Co. London, England: Macmillan & Co., Ltd. Cloth; 5 x 7¾ ins.; pp. 96. 90 cts., net.

Engineers who have not wholly given up the occasional employment of calculus analysis require two aids; a good table of integrals, and a brief statement of the methods of solving differential equations. The present book is one of several available works aiming to meet the latter requirement. A special feature is a considerable number of examples taken from engineering calculations, though not as many perhaps as might well have been given.

WATER-SUPPLY AND IRRIGATION PAPERS, U. S. GEOLOGICAL SURVEY.—Charles D. Walcott, Director. Washington, D. C.: Pub. Doc. Paper; 5¾ x 9 ins.

No. 185: Investigations on the Purification of Boston Sewage, Made at the Sanitary Research Laboratory and Sewage Experiment Station of the Massachusetts Institute of Technology; with a History of the Sewage-Disposal Problem. By C.-E. A. Winslow and Earle B. Phelps. Pp. 163; 22 illustrations in the text.

A remarkably compact and fairly comprehensive historical and descriptive review of sewage treatment methods at home and abroad occupies about two-thirds of this paper and is followed by an account of the sewage purification experiments at the station named. The latter does not include the studies of percolating or sprinkling filters, owing to a recent, and we think a wise, change in the methods of applying the sewage to these filters. The report abounds with [illegible], including many tables of analyses, and is accompanied by a good bibliography. It is one of the best papers in the series, as well as one of the most useful publications on sewage treatment ever issued.

Mechanical Drawing as a Langua[illegible]

Reviewed by George A. Orrok,* M. Am. [illegible] M. E.

UNIVERSAL DICTIONARY OF MECHANICAL DRAWING.—By George H. Follows, Associate Professor of Machine Design and Mechanical Drawing, Carnegie Technical Schools, Pittsburg. New York: Engineering News Publishing Co. Cloth; 10¾ x 13½ ins.; pp. 60; 45 illustrations in the text. $1, net.

Mr. Follows bases his "Universal Dictionary of Mechanical Drawing" on the fundamental proposition that "Mechanical Drawing is a language," with analogies to the English language, "for the positive conveying of exact information," and he defines its alphabet or lines, its words or views, and its books, or complete drawings. Numerous good examples are given of the uses and customs of the language (to continue the analogy) which are shown in 22 full page reproductions of standard drawings.

Many draftsmen and mechanics, especially those from New England, will not agree with the author's remarks on descriptive geometry, but there is no doubt that the tendency is all towards third-angle projection, and that most of our engineering and manufacturing establishments have abandoned the use of first-angle projections, as taught in the colleges. It will still be necessary for draftsmen and mechanics to be familiar with both methods, as there are manifest advantages in first-angle projections for certain constructions. As a matter of fact errors in shopwork, due to misreading of drawings, are as prevalent where "views" are used as with first-angle projections, the difficulty not being in the type of projection but in the lack of imagination on the part of the workman who cannot mentally reconstruct the work from the drawing.

The remarks on section lining and sectional views are particularly good. The chapter on dimensioning is the most valuable one in the book and should be studied by every draftsman. More drawings are faulty through careless dimensioning than for all other reasons, and, while it may be impossible to prevent workmen from scaling drawings, a complete and logical set of dimensions will go far towards eradicating the evil. The instructions for checkers are clear and concise. A novelty is the sign which the author advocates for indicating finished surfaces, which is to be commended both as to its form and the manner of application. The remarks of the author regarding the usual sign for indicating finished surfaces are very mild, considering the unsatisfactory character of the sign as usually applied.

Taken as a whole the book is a distinct step towards standardizing the usages and practice of mechanical drawing. The adoption by any drawing office of the system presented by Mr. Follows would undoubtedly reduce to a great extent the friction between drawing room and shop, which always prevails in manufacturing establishments.

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Railroad Curve Tables for Field Use.

Reviewed by Charles L. Crandall.*

RAILROAD CURVE TABLES.—Containing a Comprehensive Table of Functions of a One-Degree Curve, with Correction Quantities Giving Exact Values for any Degree of Curve, Together with Various Other Tables and Formulas, Including Radii, Natural Sines, Cosines, Tangents, Cotangents, etc. To Which is Added a Method of Finding Any Function of a Curve of Any Degree or Radius Without a Field Book. By R. S. Henderson. New York: The Engineering News Publishing Co. Cloth; 5 × 7 ins.; pp. 69; figures in the text. Cloth, $1; leather, $1.50.

The table of functions of a one-degree curve takes up 42 pages. It includes the tangent, the external, the long chord, the middle ordinate, and the x and y coordinates of the point of tangent with the origin at the point of curve and the first tangent for the axis X. The values are given for each minute of deflection angle between tangents from 0° to 98° and for each 0° 10′ from 98° to 118°. The coordinates are given only up to an angle of 50°. The table is computed for the true theoretical radius of 5,729.65 and a three-page table of corrections is given to reduce all curves to the values for the full 100-ft. chords. For those who believe in the 100-ft. chord basis, the table is very convenient, as computations are almost wholly avoided.

For those of us who have abandoned the 100-ft. chord basis and, as suggested by Wellington, use 100-ft. chords for curves up to 8°; 50-ft. chords for curves from 8° to 16°; 25-ft. chords for curves from 16° to 32°; and 10-ft. chords for all curves sharper than 32°; one-degree curve functions computed for a radius of 5,730 ft. would have suited us better, but we can use them as computed and omit corrections.

Circular functions to seven places for 10-minute intervals, as given by the author, are certainly out of the ordinary. The excuse is that three pages of tables with proper computation will give the sine, cosine, tangent and cotangent accurately to five places. Field tables to be of value should be simple; if five places are needed, they should be given for one-minute intervals even if a few more pages are required.

The turnout table given is for the stub switch and the lead is called the theoretical lead. As this switch has been abandoned by nearly all the railroads of the country it is difficult to see why a table for the point switch should not have been given instead.

In the appendix—Field Engineering without a Field Book—four formulas are given for finding an angle from its tangent. These formulas are complicated for field use, so that assuming that one could remember them and apply them accurately under field conditions, he could still go a long distance back to headquarters, get his tables, return and do his computing on a time schedule that would compare favorably with the one proposed.

In the explanations $\sin^2 \frac{1}{2} \Delta + \cos^2 \frac{1}{2} \Delta$ is placed equal $\tan^2 \frac{1}{2} \Delta$ instead of unity, a typographical error.

The book is of convenient size for field use and the hand-made figures of the tables come out sharper and clearer than type. It will find a place with the railroad engineer on account of the excellent table of functions for a one-degree curve.

THE METRIC SYSTEM.—Expressions of Opinion in Its Favor by Eminent Representatives of Various Trades, Industries, etc., etc. London, England: The Decimal Association. Paper; 5½ × 8 ins.; pp. 64.

Among those whose opinions in favor of the metric system are recorded in this booklet is Lord Kelvin. His views head the list of over eighty other contributions on the subject from representatives of different institutions, industries and trades. The British workman, says he, will be much happier at his work with a folding 50-centimeter rule, graduated to millimeters, than with a folding 2-ft. rule, graduated to eighths, sixteenths and thirty-seconds of an inch.

An extract given in the booklet from one of Lord Kelvin's speeches quotes him as saying:

> I believe I am not over-stating the truth when I say that half the time occupied by clerks and draftsmen in engineers' and surveyors' offices—I am sure at least one-half of it—is work entailed upon them by the inconvenience of the present farrago of weights and measures. The introduction of the French metrical system will produce an enormous saving in business offices of all kinds—engineering, commercial and retail shops.

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The Sanitation of Cologne.

Reviewed by George W. Fuller,* M. Am. Soc. C. E.

DIE ASSANIERUNG VON COELN.—(The Sanitation of Cologne.) Compiled by Dr. Th. Weyl, Charlottenburg, with the collaboration of Messrs. Adam, Czaplewski, Encke, Hesse, Ibach, Kühnau, Prenger and Steuernagel. Part II, Group II., Fortschritte der Ingenieurwissenschaften. Leipsig, Germany: Wilhelm Engelmann. Paper; 7¼ × 11 ins.; pp. 310; 37 folding plates and 67 text illustrations. 20 marks; American price, $8.

This detailed description of the various sanitary works of the City of Cologne, Germany, has been prepared under the direction of Dr. Th. Weyl, of Charlottenburg, by the heads of the various city departments of Cologne. Its text and numerous maps, drawings and tables show fully all leading facts and conditions as to the municipal sanitation of Cologne, which city had a population of about 373,000 in 1900. This is the fourth city to be described in this manner by Dr. Weyl. The earlier described cities were Paris, Vienna and Zurich.

The location of Cologne on the banks of the River Rhine, its topographical conditions, its distribution into various districts or zones, with the past, present and prospective development of each, is entered into at length. A detailed presentation is made of the vital statistics of the city from 1890 to 1900 and to some extent for periods preceding and following that decade.

The water-works, which date from 1872, derive their supply from a series of wells, the details of which are set forth from an engineering and analytical standpoint. The distribution system is described with thoroughness, as is true of questions as to water rates, consumption, rules, regulations, etc.

Stadt Baurat Steuernagel, well known to many American engineers through his writings upon the treatment of the sewage of Cologne by sedimentation, gives a full description of the data upon which is based the design for the sewerage system for removing both house drainage and storm water. In this part of the volume is a summary of his well-known investigations upon the clarification of sewage in comparatively small settling basins before it is discharged into the River Rhine. Reference is also made to other well-known investigations made in the vicinity of Cologne as to the effect of sewage upon the quality of the water in this river, partly as a result of requests made of the city by the Berlin authorities. With these settling basins, where the coarser suspended matters in the sewage are removed in connection with fine screens, arrangements are to be provided for treating the sewage with some disinfectant, whenever, at times of epidemics, this may be deemed necessary by the local representatives of the Imperial Health Board.

The methods pursued in the street cleaning department are described briefly. The refuse and garbage are carried outside of the city and disposed of on land. Incineration plants have been investigated, but not as yet installed.

The remaining portions of the report are rather more interesting to the medical health officer than to the engineer. They include descriptions of the various branches of sanitary inspection. Quite lengthy descriptions are given of the organization for carrying on disinfection, and also of the city laboratory, which devotes itself both to medical and sanitary matters. Numerous references are made to official city documents giving further detail as to methods pursued, and quotations are made of various sanitary regulations governing the different branches of the municipal work of the city.

ELECTRICAL WIRING AND CONSTRUCTION TABLES.—By Henry C. Horstmann and Victor H. Tousley, Authors of "Modern Wiring Diagrams and Descriptions" and "Modern Electrical Construction." Chicago, Ill.: Frederick J. Drake & Co. Morocco; 4¼ × 6¼ ins.; pp. 119; illustrated. $1.50, net.

This pocket hand-book contains much useful information for the wire man, contractor, engineer and architect. The tables and charts given have apparently been selected with much care, and the matter relating to their use and application is clearly worded and brief. The convenient size of the book for the pocket is also commendable.

The book contains tables for direct-current calculations, for alternating-current calculations, for the smallest size of wire permissible, and for the most economical loss in different installations. Tables and diagrams are given showing the proper size of conduits to accommodate different combinations or numbers of wires; also tables and data for estimating the quantity of material required for different lines of work.

*Of Hering & Fuller, Consulting Engineers, 170 Broadway, New York City.

THE DIFFERENTIAL ARCH DAM.—"D. A. D." An elementary treatise on Masonry Dams for the Use of Parties interested in Water Power Development, including a General History of the Subject. By George E. Ladshaw. Spartanburg, S. C.: The Author. Paper; 6½ × 9½ ins.; pp. 77; plates and text illustrations. For gratuitous distribution.

The author describes a patented type of masonry dam, which appears to be similar in general design to the hollow reinforced concrete dams for moderate head which are now being constructed. The dam consists of a series of arches turned between piers or buttresses. A large economy is claimed over the ordinary type of gravity dam. The pamphlet gives an intricate mathematical discussion of the theory of the design.

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Ice, Ice-Formation and Frazil.

ICE FORMATION.—With Special Reference to Anchor-Ice and Frazil. By Howard T. Barnes, M. A. Sc., D. Sc., F. R. S. C., Associate Professor of Physics, McGill University, Montreal. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 5⅛ × 9¼ ins.; pp. 200; 40 illustrations, mostly in the text. $3.

The St. Lawrence River at several points is subject to winter ice-packs which often produce high floods and destructive "ice-shoves"; the vicinity of Montreal is one of these points. In 1886 the Montreal Flood Commission was appointed to study the condition, and a guard-pier was built to divert the current of the river at Montreal to the opposite side; since then the flood and shove effects along the harbor front have been insignificant. The nature of the ice-packs in question is peculiar, and its details involve some interesting problems of Physics. The St. Lawrence does not freeze over continuously in the Montreal district, but ice-cakes assemble to form a bridge. The latter grows up-stream by the accession of more cake-ice and vertically downwards by the help of ice-needles carried in suspension in the water, which adhere to the bottom of the ice bridge and there form large growths of a more or less porous texture. Sometimes the waterway is so reduced by these ice masses that the river is dammed back and overflows its banks. Later, when the ice begins to move out, it sometimes jams and shoves high on the shores with destructive action. The ice-shoves are a part of the spring floods, which are common enough. The winter floods, however, which are caused by the reduction of waterway by ice masses, are peculiar to northern rivers.

Anchor-ice, or ground-ice, is prominently involved in the matter; by becoming detached from the bottom on sunny days it furnishes part of the cake-ice, and while still adhering to the bottom it affords lodgment to the suspended ice-needles and thereby grows greatly in thickness, so as to reduce the area of waterway. The ice-needles carried in suspension, called frazil or frazil-ice, are the other factor, and by far the more important. This form of ice is also the trouble-maker in hydraulic power plants, where it enters the headrace, adheres to and clogs the screen racks, and forms aggregations in the penstocks and waterwheels, sometimes stopping the machinery.

Ten years ago the author engaged in a study of the physical conditions surrounding the formation of frazil or spicular ice and anchor ice. (See also Eng. News June 15, 1905, p. 627). A thermometric apparatus capable of measuring temperature-differences to one-thousandth degree centigrade was constructed; the exposure elements were two coils of platinum wire whose resistance relation was measured by a Wheatstone bridge, and one of the elements was immersed in the river while the other was kept in a carefully-prepared mixture of snow and water. Various measurements under ice as well as in open water showed variable minute differences from 32° F., and the lowest temperatures were found when frazil was forming or (under ice) was present in large quantity. The lowest water-temperature measured was about —0°.006 C., or 0°.011 F. below the freezing-point.

These experiments appear to be the moving cause for the existence of the present work. Their method and general results are summarized in two chapters entitled "Precise Temperature Measurements" and "River Temperatures." But it may well be questioned whether these are the most important part of the book. The six other chapters are concerned with the following subjects: Heat Transfer (26 pp.); Physical Constants of Ice (44 pp.); Formation and Structure of Ice (24 pp.); Sheet, Frazil and Anchor-Ice, their Production, Growth and Effects (38 pp.); Old Theories of Frazil and Anchor Ice (41 pp.); Methods of Dealing with Frazil in Hydraulic Power Plants (23 pp.) Judging by the general trend of the text as well as by proportionate space, the title of the book might have been written "Frazil and Anchor-Ice."

Three of the subjects embraced in the chapters outside of those dealing with the author's experiments will prove specially interesting: the critical citation of best determinations of the physical constants of ice, with description of some of the experimental methods; the copious citations from the observations and conclusions of the Montreal Flood Commission; and the description of various ways of overcoming trouble from frazil in water-power plants. The last is in some relation to the subject of water temperatures. The author showed, by his experiments, that at times when frazil is not formed and has no agglomerative tendency the water temperature is slightly above the freezing point, by a few thousands to a few hundredths of a degree, and that under no circumstances is water in nature colder than about one-one-hundredth degree below freezing. Now the trouble at screen-racks and in penstocks and wheel-cases is primarily due to adhesion and agglomeration of the frazil carried in the water. If, therefore, the temperature of the water can be raised say 0.02° F. during its passage through the screen-racks, trouble from frazil will be avoided. On the other hand, the formation of anchor-ice in the headrace can be avoided by maintaining a forebay quiet enough to freeze over; for, the formation of anchor-ice is due to upward radiation of heat from the bottom in clear nights, and never takes place in sunshine or under a cover of surface ice.

While the theory of the formation of anchor-ice is repeatedly advanced and argued, the formation of frazil is not at all clearly elucidated. We learn that frazil does not form in quiet water, but only in rapid-flowing disturbed water, best at the lower part of rapids or below a water-fall; the conditions must be such as to bring the entire depth of water to near the freezing-point. But we are not told whether frazil always forms at the surface, or also below the surface; and if the latter be assumed on general evidence, then the physical procedure is left unexplained. The freezing-point is lowered with increasing depth (increasing pressure), and most of the heat-abstraction takes place at the surface, so that it would appear that the needle-ice must form at the surface if at all.

The subject-matter of Professor Barnes' book is of unusual interest, and as a pioneer work the author's effort deserves the more consideration. That the arrangement of the matter and the progression of the argument are sometimes lacking in directness, and that at a few points the language is a bit awkward, is therefore of minor import. Unclear language is especially noticed where Quincke's theory of ice formation is presented; it is difficult to get a rational view of the theory from this text. Carelessness in writing or editing are also to be held responsible for the consistent use of "sheering" where "shearing" is intended, for giving Young's modulus in grm. / cm. sec², and similar defects.

To our view a serious fault of the book is its total silence on the subject of trouble with ice at water-works intakes. There is no lack of literature on the subject; Mr. C. W. Hubbell, in an article describing the history of ice-trouble at the Detroit intakes (Engineering News, Aug. 13, 1903, pp. 147-149) gives a list of over thirty references, among them several of the author's own writings. It can hardly be said that the matter is secondary to ice-troubles in water power plants, as the story of the Detroit intakes suffices to demonstrate. In fact, the water-works intake is a much more difficult problem, in its relation to ice, than the power-house intake, because of location, and because of the fact that both anchor-ice and frazil have to be fought as against frazil alone in the power plant. Inclusion of a comprehensive discussion of trouble at water-works intakes would in judgment have added very considerably to value of the book. A study of the literatu the subject might have indicated, moreover, the radiation theory of anchor-ice formation been accepted for a long time past, and tha peated insistence on it is therefore not requ

The work as a whole merits a wide circul and an appreciative reception.

A Descriptive Index to Periodical Engineeri Literature.

THE ENGINEERING INDEX.—Vol. IV. Five Y 1901-1905. Edited by Henry Harrison Suple Sc., M. Am. Soc. M. E., and J. H. Cuntz, C M. E., Assoc. Am. Inst. E. E.; in cooperation Charles Buxton Going, Ph. B., Managing Edit The Engineering Magazine. New York and Lon The Engineering Magazine. Cloth; 6½ × 9½ ins. 1,234. $7.50.

The thanks of both the engineering profes and the engineering press are due the compil editors and publishers of this most useful solidated descriptive index of the engineering allied literature of the five years 1901-5. S 250 journals, in six languages, are not only dexed in this huge volume, but a brief descripti of each article is given. These descriptions of enable the searcher to decide whether the co plete article will be of service to him, thus s ing an immense amount of time. The free u of cross-references and of catch words at head of each page are great aids to quick ref ence.

One change or addition we should like to s is the giving of more information regarding the scope of serial articles. Of these only the initial one is entered, with the statement that it is a serial. One would often like to know how extensive the series is, and also, when the series is not published in consecutive numbers of the journal, just which numbers should be seen. Moreover, it may happen that numbers after the first need additional cross-indexing.

It should be noted that the Index is the fourth of a series which covers the years 1884 to 1905, although the first volume is unfortunately out of print. The first two volumes were compiled in behalf of the Journal of the Association of Engineering Societies, by and under the direction of the late Prof. J. B. Johnson. The publishers announce that the Index will be issued yearly hereafter—for which all should be duly thankful.

We wish we could so impress the usefulness of this Index upon the members of the engineering profession that every one who could afford to do so would buy it. If its value were appreciated most engineers, or at least engineers with or having access to libraries, would realize that they cannot afford to be without it.

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CLIMATOLOGY OF THE UNITED STATES.—By Alfred Judson Henry, Professor of Meteorology. Prepared under direction of Willis L. Moore, Chief U. S. Weather Bureau. Bulletin Q, Weather Bureau, U. S. Department of Agriculture. Washington, D. C.: Pub. Doc. Cloth; 9 × 12 ins.; pp. 1,012; 34 plates, 6 text figures, and numerous tables. $10.

Although issued primarily to meet the wants of agriculturalists, this volume contains a vast amount of compact, well-arranged information needed almost daily by engineers; so much, in fact, as to make certain omissions very noticeable and regrettable. What these omissions are will be stated later.

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Engineers will see that for their purposes the data given in this volume are generally ample for everything except rainfall and wind velocities, the latter being entirely lacking. We do not say this in condemnation, as the "bulletin" was not prepared for engineers, but in order that any one interested may judge for himself whether the information that is given will be worth to him the price that he must pay to obtain it. Maximum rainfalls for 24 hours and associated data, and also maximum wind pressures and prevalence of high winds are of course of great value to engineers; and so, it would seem to us, must they be to agriculturalists as well. It so happens that there is considerable waste space on most of the pages devoted to individual station records, so that much additional information could have been given without greatly enlarging the bulletin. We realize, however, the difficulty of setting a limit to statistical data on so broad a subject, are very thankful for what we find in the volume and for the handsome way in which it is presented.

Publications Received.

AMERICAN INSTITUTE OF ARCHITECTS.—Proceedings of the 39th Annual Convention, Held in The Octagon, Dec. 29, 1905, and the New Willard Hotel, Washington, D. C., Jan. 9, 10, 11, 1906. Published by the Board of Directors, A. I. A., under direction Committee on Education and Publication. Glenn Brown, Editor. Paper; 7¼ × 9¾ ins.; pp. 267; illustrated.

AMERICAN TRADE WITH THE LEVANT AND ITS POSSIBILITIES.—By Aris. Tsakonas, M. E. Philadelphia, Pa.: The Author (5212 Jefferson St.). Paper; 6 × 9 ins.; pp. 15. For free distribution.

BOARD OF HARBOR AND LAND COMMISSIONERS.—Annual Report for the Year 1906. (George E. Smith, Chairman.) Boston, Mass.: Pub. Doc. (No. 11). Cloth; 5½ × 9 ins.; pp. 80; one folding plate.

BOARD OF RAPID TRANSIT RAILROAD COMMISSIONERS.—Report for the City of New York, for the Year Ending December 31, 1905. New York: The Board (Bion L. Burrows, Secy., 320 Broadway). Paper; 7 × 10¼ ins.; pp. 262; folding and other plates.

DER BRUECKENBAU.—After Lectures Given in the Finnish Polytechnic Institute at Helsingfors by M. Strukel, Professor of Engineering. Atlas, Part II. Helsingfors, Finland: Förlagsaktiebolaget Helios. Leipzig, Germany: A. Twietmeyer. Paper; 7¾ × 10¼ ins.; 41 plates. 10 marks; American price, $3.

BULLETINS, U. S. GEOLOGICAL SURVEY.—Charles D. Walcott, Director. Washington, D. C.: Pub. Doc. Paper; 5¾ × 9 ins.

No. 302: The Areas of the United States, the States, and the Territories. By Henry Gannett. Pp. 9; one plate.

COMBUSTION AND SMOKELESS FURNACES.—By Jos. W. Hays. New York. Hill Publishing Co. Cloth; 6 × 9½ ins.; pp. 104; 15 text illustrations. $1.50.

GEOLOGIC ATLAS OF THE UNITED STATES.—U. S. Geological Survey. Charles D. Walcott, Director. Washington, D. C.: Pub. Doc. Stiff paper; 18½ × 21¾ ins.

No. 141: Bald Mountain-Dayton Folio. Wyoming. Pp. 16; nine plates and six text figures.

DER GRUNDBAU.—After Lectures Given in the Finnish Polytechnic Institute at Helsingfors by M. Strukel, Professor of Engineering. Second edition, enlarged. Helsingfors, Finland: Förlagsaktiebolaget Helios. Leipzig, Germany: A. Twietmeyer. Paper; 7¾ × 10¼ ins.; pp. 347; 118 illustrations in the text; atlas in separate binding, containing 36 plates. 18 marks; American price, $5.40.

ELECTRICAL ENGINEERING.—An Elementary Text-Book. By E. Rosenberg, Chief Electrical Engineer at Messrs. Körting Bros., Hanover. Translated by W. W. Haldane Gee, A. M. I. E. E., Professor of Applied Physics at the Municipal School of Technology, Manchester, and Carl Kinzbrunner, Lecturer on Electrical Engineering at the Municipal School of Technology, Manchester. Revised and brought down to date for the American market by Edward B. Raymond, B. S., Assoc. M. Am. Inst. E. E. New York: John Wiley & Sons. Cloth; 5¾ × 9 ins.; pp. 347; 333 illustrations in the text. $2, net.

HIGHWAY IMPROVEMENTS, NEW YORK STATE.—Instructions to Engineers, to Guide Them in Making Surveys, Preparing Plans, Specifications and Estimates, and in Superintending Construction of Highway Improvements in New York State, under Chapter 115, Laws of 1898, and Acts Amendatory Thereto. State of New York, Department of State Engineer and Surveyor. Albany, N. Y.: Pub. Doc. Flexible cloth, 5½ × 7½ ins.; pp. 41; six folding plates.

IMPROVEMENT OF THE ERIE, OSWEGO AND CHAMPLAIN CANALS.—Under Chapter 147, Laws of 1903. Known as the Barge Canal Improvement. State of New York, Department of State Engineer and Surveyor. Albany, N. Y.: Pub. Doc. Flexible cloth; 4¾ × 7 ins.

Instruction for Preliminary Work. Pp. 75; seven folding plates.

Rules Governing Construction. Pp. 42.

LEAD SMELTING AND REFINING.—With Some Notes on Lead Mining. Edited by Walter Renton Ingalls. New York and London: The Engineering and Mining Journal. Cloth; 6 × 9½ ins.; pp. 327; 51 illustrations, partly in the text. $3.

LIBRARY OF CONGRESS.—Report of the Librarian of Congress and Report of the Superintendent of the Library Building and Grounds, for the Fiscal Year ending June 30, 1906. (Herbert Putnam, Librarian.) Washington, D. C.: Pub. Doc. Cloth; 5¾ × 9½ ins.; pp. 175; six plates.

THE LUMBER CUT OF THE UNITED STATES IN 1905.—By S. R. Kellogg, Forest Assistant, Forest Service. Circular 52, Forest Service, U. S. Department of Agriculture; Gifford Pinchot, Forester. Washington, D. C.. Pub. Doc. Paper; 5¾ × 9 ins.; pp. 23; one folding table.

MATHEMATICAL DRAWING.—By G. M. Minchin, M. A., F. R. S., Professor of Applied Mathematics at the Royal Indian Engineering College, Cooper's Hill, and J. B. Dale, M. A., Assistant Professor of Mathematics at King's College, London. London, England: Edward Arnold. New York: Longmans, Green & Co. Cloth; 5½ × 8¾ ins.; pp. 145; 102 figures in the text. $2.10, net.

MODERN PRACTICAL CARPENTRY.—For the use of Workmen, Builders, Architects and Engineers. By George Ellis, Author of "Modern Practical Joinery," etc. London, England: B. T. Batsford. New York: The Industrial Publication Co. Cloth; 7 × 10½ ins.; pp. 390; folding and other plates and numerous text illustrations. $5, net.

NATIONAL BOARD OF FIRE UNDERWRITERS.—Rules and Requirements for the Construction, Installation and Use of Gasolene Vapor Gas Lighting Machines, Lamps and Systems, as Recommended by its Committee of Consulting Engineers. Edition of 1906. Paper; 3½ × 5½ ins.; pp. 27.

NATIONAL BOARD OF FIRE UNDERWRITERS.—Uniform Requirements Recommended for Use of Boards, Bureaus and Inspectors, relating to "Slow Burning" Construction, "Inferior" Construction, General Hazards, Oil Rooms, General Protection, Stairway and Elevator Closures, Watchmen, Thermostats and Miscellaneous Matters. Prepared by the National Fire Protection Association (Address Secretary, 382 Ohio St., Chicago). Paper; 3½ × 5½ ins.; pp. 34; illustrated.

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